B E R K E L E Y   S C I E N T I F I C   T R A N S L A T I O N   S E R V I C E

2161 Shattuck Avenue
Suite 315
Berkeley, CA 94704 USA
Voice 510/548-4665
Fax 510/548-4666
CompuServe 71773, 1422

PROCESS FOR MANUFACTURING DECOMPOSABLE, THIN-WALLED STARCH-BASED MOLDINGS

TRANSLATION FROM: German original
WO 91/12186

TRANSLATION BY: BERKELEY SCIENTIFIC
TRANSLATION SERVICE, INC.
800-488-9884

DATE: May 1994

Carboxymethyl cellulose pg 8
15mm fibers pg 8 #17 pg 8
mag. filler pg 8

WORLD ORGANIZATION FOR INTELLECTUAL PROPERTY
International office
INTERNATIONAL APPLICATION PUBLISHED ACCORDING TO THE AGREEMENT ON INTERNATIONAL COOPERATION IN THE AREA OF PATENTS (PCT)

International patent classification: B65D 65/46, A21D 13/00
International publication number: WO 91/12186
International publication date: 22 August 1991

International file: PCT/AT91/00019
International application date: 5 February 1991
Priority dates:
A 252/90 — 6 February 1990
A 1241/90 — 7 June 1990
A 1783/90 — 31 August 1990

Applicant (*for all designated countries except US*): FRANZ HAAS WAFFELMASCHINEN INDUSTRIEGESELLSCHAFT M.B.H [AT/AT]; Pragerstrasse 124, A-1210 Vienna, Austria

Inventor; and Inventor/applicant (*only for US*): TIEFENBACHER, Karl [AT/AT]; Geblergasse 78, A-1170 Vienna, Austria. HAAS, Franz [AT/AT]; Kreuzgasse, A-2100 Leobendorf, Austria, HAAS, Johann [AT/AT]; Seitweg 4, A-3400 Klosterneuburg, Austria.

Attorney: BERGER, Erhard; Siebensterngasse 39, A-10 Vienna, Austria.

Designated countries: AT (european patent), AU, B (european patent), BG, BR, CA, CH (european patent),DE (european patent), DK (european patent), ES (european patent), FI, FR (european patent), GB (european patent), GR (european patent), HU, IT (european patent), JP, KR, LU (european patent), MC, NL (european patent), NO, PL, RO, SE (european patent), SU, US.

Published *With international research report. Before expiration of the time allowed for changing the claims, publication will be repeated in case changes are made.*

Title: **PROCESS FOR MANUFACTURING DECOMPOSABLE, THIN-WALLED STARCH-BASED MOLDINGS**

Abstract:
Decomposable thin-walled moldings, such as goblets, plates, trays and the like, which possess high mechanical stability can be manufactured by a baking process similar to that used to make edible waffles. The batter used is an essentially fat-free batter containing water and, as the main ingredient, a product with a high starch content, preferably a starch, as well as a separating agent in the form of medium or long-chain fatty acids and/or their salts and/or acid derivatives. These compounds may also be used with, or in certain cases partly or completely replaced by polyhydrogen siloxanes. In addition, the batters may contain thickeners, fillers, moisturizing agents, colorants, texture consolidators, preservatives, and antioxidants. The baked products are finally conditioned to a moisture content of 6 to 22 wt.%.

PROCESS FOR MANUFACTURING DECOMPOSABLE, THIN-WALLED STARCH-BASED MOLDINGS

The present invention concerns a process for manufacturing decomposable, thin-walled moldings by applying a starch-based batter onto the lower half of a multicomponent form, preferentially a two-part form, baking the mold by heating the closed form, and then conditioning the baked product.

The following molds can be used, for example, with the aid of the process according to the invention: goblets, plates, fast food packaging, packaging inserts, so-called trays, sheets and webs made of materials similar to paper or cardboard (for example, inserts in boxes of chocolates) or for securing filling materials by the piece, or as a raw material for composite materials to be used as packings, e.g., in combination with plastics used, for example, as fillers for protecting packaged materials from shock, as more or less regularly formed small particles, similar to the well-known styropore chips.

Within the framework of the present invention, the term thin-walled is to be understood as a wall thickness that is on the one hand fracture-proof and tear resistant, and on the other hand, can still be baked between two halves of a mold on conventional automatic waffle makers (see, for example, US Patents 4,438,685, 4,648,314, and German Offenlegungsschrift 3 346 970).

Products of the abovementioned type that are currently on the market are extensively produced from plastic or paper, and use petroleum or wood as the raw material for their production. Fast growing plant materials like starches or oil-producing plants are not yet used for manufacturing such products that could be described in the broader sense as packaging materials. Plant starches as well as plant oils and fats are currently available on a worldwide basis as industrial raw materials for uses beyond foods.

In particular, starches represent an interesting raw material that forms rigid structures by means of swelling, heating, or cross-linking reactions using physical and chemical processes, such as are well known in baked materials, e.g., bread crusts.

In the area of biscuits and cakes, products are available that are made with edible waffles shaped as sheets (flat waffles, wafers), ice cream cones, goblets, etc., which have an additional packaging function, like for ice cream, but cannot fulfill other essential requirements with respect to stability and protection required of a packaging material, due to the typical properties: crispness, fragility, sensitivity to moisture, subject to oxidation.

The manufacture of edible waffles is carried out according to a variety of well-known descriptions found in the patent and technical literature (see, for example: DE 17 82 502, DE 29 29 496, DE 32 39 871, P.E. Pritchard, A.H. Emery, D.J. Stevens (1975), The Influence of Ingredients on the Properties of Wafer Sheets, FMBRA Report No. 66, - D.J.R. Manley, Technology of biscuits, crackers, and cookies, Ellis Horwood Limited, 1983, page 222 ff., - E. Winter, CCB Rev. Chocolate, Confectionary & Baking, 5 (3), 19; 1980).

The recipes for the waffle batter regularly contain a series of minor components essential to the manufacture of this product, in addition to the most important components from a quantitative point of view, namely wheat flour and water:

Rising agents: sodium bicarbonate is used in amounts of 0.2 - 0.8 % with respect to the amount of flour. It can be partially substituted by ammonium bicarbonate, or yeast can be used.

Fats: The incorporation of fats/oils is required in amounts of 1% - 3% with respect to the amount of flour used, in order to make the removal of the waffles from the baking mold easier (separating agent). Magnesium oxide is also specifically recommended for this purpose. However, this can lead to problems with regard to stability of the baking utensils due to the basic properties of this material.

Lecithin: Lecithin is used as an emulsifier in the production of waffles, and can also be considered as a separating agent when used in larger amounts.

The use of oils and fats in such recipes is not required primarily for reasons of taste, but more to prevent sticking to the baking mold. Lecithin also has a positive effect on the removal from the mold, and emulsifies the oil/fat component in the aqueous waffle batter.

The abovementioned recipe components of fat and lecithin are often completely or partially introduced by the addition of egg powder, milk powder, or soy meal. Such additives are accompanied by effects on the structure, color, and taste of the waffles. This is just as true for possible uses of sucrose or glucose (0 - 3% with respect to the amount of flour used). Salt is used as a seasoning in amounts between 0 and 0.6% with respect to the amount of flour used.

Additional optional additives are whey powder, aromas, or colorants.

The ready mixed batter is generally baked at a temperature of 160°C to 180°C for 1, 2, or 3 minutes.

The porous structure of such waffles caused by the rising agent and the distribution of the fat component, even if only a small amount, over a very large surface, causes rancidity very quickly for unpackaged waffles. This is caused by light and air induced oxidative decomposition of the fat, and occurs within days or weeks.

In order to manufacture light or white wafers, batters are used that use starch materials in part or entirely, instead of wheat flour, like cereal and potato starch. In this case, it is necessary either to use oil/fat as the separating agent, for which the concentration must be increased compared to normal waffle batters, in order to prevent sticking to the baking mold, or the surfaces of the baking mold must be specially prepared, i.e., polished and/or chrome plated. Separating oils,

paraffins, or waxes are alternately used to treat the baking form. However, this leads to problems in the release of steam, and often produces deformed products.

During the baking process, a strengthening of the structure is produced by agglutination of starches.

The adhesive component of the flour being used contributes to the rigidity and texture of the product through the introduction of bound water into the batter and its denaturation during the baking process by means of cross linking in the waffle structure.

In the production of waffles, the partial agglutination of the starches plays a significant role in providing structure to the product, along with solidification caused by the albumin.

This agglutination begins at approximately 60°C, and can only occur in the presence of free water. If too little water is available, the agglutination temperature initially increases steadily, and the agglutination finally comes to a stop.

In parallel to the water requirement for agglutination is an increasing development of steam caused by heating during the baking process, which produces a sudden decrease in the amount of available water, but is very important for the relaxation and formation of the pore structure of the waffle product. As the fat concentration increases in the recipe, increasingly larger amounts of starch granules are coated with fat, and these hydrophobic components hinder the emission of steam, leading to sudden and often unequal relaxation and poor formation of the surface of the waffle product to be baked. The use of lecithin counteracts these processes.

Using well-known production methods it is not possible in the first place to exclude the negative effect of baking fat on the structural properties, and in the second place to ignore the changes in taste and smell that occur by hydrolytic and oxidative processes during the periods of use. These rapid alterations in smell and taste are delayed by tight packaging that is impermeable to light and

air for waffle products, or at least for the consumer, is concealed by the presence of positive baking aromas for a certain period of time. Three components in the recipe are responsible for these alterations to a first approximation:

1. The added fat: An improvement can be achieved here by using only saturated fats, and the shelf life of the waffle product is increased by 50 to 200%. However, unsaturated fats are also contained in the flour.

2. The lecithins used as emulsifiers also contain unsaturated fatty acids. A reduction in the amount of lecithin used (direct addition or through other additives, such as described above) is certainly possible, but it makes the technological procedure of baking more difficult, and lowers the quality of the final product.

3. The pH is increased by the use of alkaline rising agents, and this favors the above-mentioned alterations.

It was unexpectedly discovered that waffle-like products could be baked by using medium- or long-chain fatty acids and/or their salts and/or their acid derivatives, and that the addition of fats and lecithin could be completely avoided, and even the addition of rising agents could be eliminated in most cases.

This is even more surprising since experiments with similar materials with respect to their separating properties, such as waxes and paraffins, which have often been used as separating agents, have been negative.

It was also discovered that polymethyl hydrogen siloxane could also be used along with the aforementioned separating agent or, in individual cases, can also completely replace it.

The preferred polymethyl hydrogen siloxanes have the general formula

$$R_3SiO(SiH(CH_3)O)_nSiR_3$$

where R indicates H, a methyl or alkyl, and when R is a methyl, n is an integer between approximately 40 and 100.

The process of the type defined above is accordingly characterized by the fact that in order to obtain a product having a sticky, firm, high mechanical stability,

1) one of the following ingredients is added to the essentially fat-free batter:

a) 30 to 63 wt.% , and preferentially 42.0 to 58.0 wt.% of water;

b) 27.0 to 69 wt.% as the basic starch, and preferentially 36 to 56.5 wt.% , and in particular, 44 to 49 wt.% of a starch or a mixture of different starches and/or a flour or flour mixture;

c) a separating agent consisting of 0.04 to 11 wt.% , and preferentially 0.2 to 4.5 wt.% of one or more medium- or long-chain, possibly substituted, fatty acids and/or their salts and/or their acid derivatives, e.g., acid amides - if necessary, 0.5 to 6.5 wt.% , and preferentially 0.1 to 4.2 wt.% of polymethylene hydrogen siloxane can possibly be used along with these compounds, or as a partial replacement, or in some cases even as a complete replacement, wherein the concentration of polymethyl hydrogen siloxanes should not in general exceed 3 wt.% in case both compound groups are used with high concentrations of fatty acids or their compounds;

d) 0 to 10 wt.% , and preferentially 0.1 to 7.5 wt.% of a thickening agent, and in particular 1.0 to 5.5 wt.% of rising starches, preagglutinated starches, or baking scraps and/or 0 to 2 wt.% , and preferentially 0 to 1.0 wt.% of guar flour, pectin,

carob seed flour, carboxy methyl cellulose, and/or 0 to 5.5 wt.% , and preferentially 0 to 3 wt.% gum arabicum.

e) 0 to 16.0 wt.% , and preferentially 0 to 11 wt.% of raw materials rich in cellulose - in cases of pulps, up to 26.9 wt.% and/or other plant fibers and/or plastic, glass, metal, carbon, and other fibers;

f) 0 to 10 wt.% , and preferentially 0 to 7.5 wt.% of non-fibrous fillers, such as calcium carbonate,
carbon,
talcum,
titanium dioxide,
silica gel,
aluminum oxide;
0 to 3 wt.% , and preferentially 0 to 2.5 wt.% shellac,
0 to 2 wt.% , and preferentially 0 to 1 wt.% of powdered soy albumen, powdered wheat gluten,
powdered chicken albumin, powdered casein, and
powdered caseinate; powdered caseinate [repeated term];

g) as a moisturizing agent
0-3.5 wt.% , and preferentially 0-2.5 wt.% of cooking salt and/or
0-2.5 wt.% , and preferentially 0-1.5 wt.% of glycerine, glycol, and/or
0-4.5 wt.% , and preferentially 0-3.5 wt.% sorbite;

h) as a colorant
0-10 wt.% , and preferentially 0-7.5 wt.% of inorganic pigments, and/or
0-0.1 wt.% of natural and synthetic dyes, and/or
0-2.5 wt.% , and preferentially 0-1 wt.% caramel, and/or

Medium and long chain fatty acids are used, preferentially with chain lengths greater than C12, and in particular C16 and C18.

The term "medium and long chain fatty acid" includes the chain length distributions that typically occur in production from vegetable and animal fats. This means that, for example, the term "stearic acid" indicates that the predominant component is stearic acid, but that in addition the usual fatty acid spectrum consisting of, for example, solidified plant oils and fats, is present, i.e., shorter or longer chain length fatty acids are still present, as well as the minor components of the corresponding unsaturated fatty acids.

The abovementioned effect is also achieved with salts of fatty acids, and preferentially stearic acids, from which Ca-, Mg-, Al-, and zinc stearate should be mentioned.

The presence of the fatty acids described, or their salts or acid derivatives, allows the production of molded products using a variety of high-starch content raw materials.

It has already been mentioned that the fatty acids or their salts or acid derivatives can, if necessary, be replaced by polymethyl hydrogen siloxanes.

Based on his knowledge, the specialist must anticipate the fact that the use of these polysiloxanes at temperatures in excess of 120°C is affected by the formation of covalent bonds with OH-groups, e.g., the starches. The formation of a hydrophobic surface then occurs, as in the case of starch granules. This hinders the release of steam and formation of an agglutinated starch matrix.

However, it is surprising that the breakup of the structure of starch granules that can be detected with an electron microscope is not hindered by the polysiloxane mentioned here when a continuous starch matrix is formed. It leads to a stiffening of the matrix, even if very slight, and for siloxane concentrations in the lower range between 0.05 and a maximum of 2 wt.% to a

certain separating effect, which helps during removal from the mold. This is possibly due to the binding of soluble components of the batter that are responsible for holding it together.

The simultaneous crosslinking of the polysiloxanes and their partial rehydrolysis by the steam present at higher temperatures nonetheless works against good deformability, especially for concentrations above 2 wt.% , especially for higher polysiloxane concentrations. Boundary layers are formed on the baking mold, which lead to sticking of the molding to the baking mold after repeated baking cycles. Use of the above-defined fatty acids or their salts or acid derivatives can again be used to counter this effect.

The foregoing explanations show that the fatty acids or their salts or acid derivatives are preferred as the separating agent for use within the framework of the present invention.

Rising agents like sodium bicarbonate increase the relaxation due to steam in the baked materials during waffle production and related baking processes.

The products are porous, light, and fragile. The use of a rising agent is not absolutely necessary in the procedure according to the invention, and contributes only a small relaxation effect. The porosity of the product can be controlled here exclusively by adjusting the water content, which leads to a material density in the range of 0.08 to 0.38 and preferentially 0.12 to 0.30 g/cm^3.

If a higher porosity is desired for some reason, this can only conditionally be achieved with starch recipes (no cereal flour) by the addition of rising agents.

The expression used within the framework of the definition of the invention "essentially fat-free batter" means that the batter has no fat or oil added to it; it contains only whatever fat is introduced by the basic starch material. Thus, potato, corn, tapioca, rice, and wheat starches have a fat content lying below 0.6 wt.% , and type 550 wheat flour or type 997 rye flour contains less than 1.4 wt.%.

0-1 wt.% of carbon black, and/or

0-3.5 wt.% , and preferentially 0-2.5 wt.% cacao powder;

i) a zirconium salt solution as a structural stiffener, preferentially as an alkaline solution of ammonium zirconium carbonate, wherein the zirconium compound content expressed as ZrO_2 is present as 0 - 0.1 wt.% . and preferentially 0.01 to 0.05 wt.% ;

k) 0-0.25 wt.% , and preferentially 0-0.1 wt.% of preservative, and

l) 0-0.5 wt.% , and preferentially 0-0.1 wt.% of antioxidants;

2) the mold-filling batter is baked for 25 to 230 seconds at 145 - 230°C, and

3) the product obtained by conditioning is adjusted to have a moisture content of 6 wt.% to 22 wt.%.

The effect of the fatty acids mentioned here and/or their salts and/or their acid derivatives, or the polysiloxanes mentioned as additives in place of the above-described fats/oils, or emulsifiers, which allow the production of a baked product having the mechanical properties described below, is, for the time being, still independent of the degree of saturation of the fatty acids used, but can preferentially be established with saturated or simple unsaturated fatty acids and hydroxy fatty acids.

However, it should be pointed out that the high oxidation stability of the product that is described later is achieved in particular with saturated fatty acids.

Alongside the extensively described fatty acids and their salts and derivatives, or the polysiloxanes used as agents for the production of oxygen-stabilized products and as agents that positively affect the structure formation of the product and removal from the machine, the following raw materials required or useable for manufacturing the product made according to the invention are included, instead of the conventional fats and emulsifiers.

- water,
- starches or raw materials rich in starch,
- thickening agents,
- fibers, preferentially solid materials rich in cellulose,
- moisture retention agents,
- colorants,
- preservatives, and
- antioxidants.

As has been mentioned earlier, 30 to 63 wt.% of water is added to the batter in the procedure according to the invention. This amount does not include the "bound" water introduced by additives, with the exception of additives that contain a very large amount of "free" water, e.g., pulp.

The raw materials used in the procedure according to the invention have a natural equilibrium moisture with which they generally achieve an especially good storage ability under conventional production and storage conditions.

This predominantly consists of water that has a strongly reduced solvent capability, and differs significantly from free water, for example, in its mobility, boiling- and freezing-behavior. (Constitutional water, vicinal water, multi-layer water, by O. FENNEMA "FOOD CHEMISTRY" 2nd Edition, Marcel Dekker, New York, 1985, page 23 ff).

Removal of this water component by appropriate rigorous drying conditions is accompanied by irreversible changes in the material properties. This is especially true for the primary raw materials, the polysaccharides, where distinctive hysteresis phenomena are observed in comparing the adsorption and desorption isotherms.

It is thus neither necessary nor meaningful to use specially dried raw materials or materials adjusted to a specific water content in the procedure according to the invention.

The following table shows the water content in the recipes used, which are generally raw materials used in the powdered form.

	Water content wt.%	
potato starch	15.5-18.6	%
corn starch	12.6	%
wheat starch	13.5	%
tapioca starch	12.4	%
rice starch	13.8	%
amylo corn starch [?]	14.4	%
pea starch	11.4	%
wheat flour	12.2-14.6	%
rye flour	14.2	%
K-rising starch	10.0	%
M-rising starch	5.0-7.0	%
guar flour	4.0	%
carboxy methyl cellulose	7.0	%
pectin	7.0-10.0	%
cellullose	6.0-10.0	%
straw	7.2	%
bran	13.1	%

flax	9.4	%
dried beet pulp	8.7	%
PHB	0.3	%
magnesium stearate	3.5	%
calcium stearate	2.0	%
talcum	0.1	%
TiO_2	0.2	%
Al_2O_3	4.6	%
silica gel	1.0	%
carbon (Norit)	10.0	%
acetyl cellulose	4.3	%
caseinate	7.4	%
casein	9.0	%
soy albumin	6.0	%
chicken albumin powder	8.5	%
wood flour	17.0-36.0	%
thin starch paste	61.7%; 57	%
pressed pulps	84.0	%

Batters with water contents lying below 40 wt.% are usually not cohesive, below 44 wt.% they are usually plastic, above 45 wt.% they are usually viscous, and capable of flowing, to the point of having thin liquid properties.

However, these boundaries are dependent on the water bonding to the starch-containing raw material used, the concentration of the thickening agent, and the cellulose-containing raw materials.

Starches or starch-containing raw materials make up the major quantitative component of solids in the recipe, as will be obvious from the recipes to be shown further below. In order to achieve sufficient mechanical rigidity, starch types are preferred with a large increase in viscosity and thus high rigidity at the onset of agglutination, such as potato starch. Potato starch is used preferentially and particularly in amounts between 10% and 100%. However, other types of starches can also be added to this starch component, in particular, wheat starch, rice starch, or even flours, particularly wheat flour.

The most important function of starch-containing raw materials in the production process is the formation of the structure by swelling, agglutination, and crosslinking. These processes are essentially affected by

- the structure of the starch granules, especially the type of intercalation of the amylose in the amylopectin matrix
- the extent, type, and manner of release of the amylose
- ionic and nonionic accompanying materials.

The complexing of the amylose by lipids and other properties referring back to the amylose fractions should be especially observed in the use of cereal starches, and could even lead occasionally to a partial weakening of the structure of the molding, as well as to the formation of cracks.

For these reasons, potato and tapioca starches, as well as cornstarch, are preferred to wheat starch, wheat flour, and rice starch, for example.

In practice, the use of 100% potato starch, tapioca, or cornstarch is preferred, but the use of pure cereal flour, as well as pure rice-, wheat-, amylo corn-, or wax corn starch is less desirable.

As is shown in individual recipe examples, a positive effect of the separating agents can likewise be achieved by the use of flours alone, without the use of starches, when

1. the limited oxidative stability is accepted as a tradeoff, or is increased by the addition of antioxidants

2. the amount of separating agents is increased or the amount of flour is decreased by the dilution effect (cellulose, starch)

3. as shown in recipe No. 64, baking is carried out with pastose, dough-type batters.

The use of materials made of cereal flours which are not capable of flowing leads to a reduced extraction of soluble flour components, which are responsible for the retention of adhesive properties. This enables a reduction in the requirement for separating agents.

The production of the product according to the invention assumes the use of homogeneous materials for the primary forming process. In order to prevent sedimentation of the raw material particles used, especially starches, it is desirable to use a thickening agent. A variety of well-known additives are suitable for this purpose:

1. Agglutinated starches or starch-containing products, which can be prepared as finished products, like swelling starches, swelling flours, or by agglutination immediately before the batter is prepared. In general, between 1 and 10 wt.% of the total starch content should be agglutinated, while the optimum lies between 2 and 5 wt.%, depending on the type of starch/flour.

2. Alternatively, conventional gels and thickening agents can be used, preferentially guar seed flour, carob seed flour, carrageen, pectin, modified starches, and carboxy methyl cellulose.

The concentrations should lie between 0.1 and 1.0 wt.%, and preferentially 0.3 to 0.8 wt.% with respect to the starch base.

A combined application of agents is also possible according to 1 and 2.

The sedimentation of the starch granules in batters that are capable of flowing can likewise be hindered by intensive stirring before administering the dosage. Indeed, the use of thickened materials is technologically advantageous for troublefree processing of batters that contain pure starches as the starch-enriched raw material, or additional starch in amounts greater than 4 wt.% along with cereal flours.

The use of thickening agents for plastic or non-cohesive batters is also not excluded.

The properties of the product to be manufactured are improved by incorporation of fibrous raw materials (natural fibers, artificial fibers, glass fibers), insofar as rigidity is concerned, especially by the incorporation of cellulose-enriched raw materials. Cellullose, bran, straw, beet fiber materials, and wood shavings can be advantageously used.

The cellulose is advantageously used in the form of a dry powder with fiber lengths between 30 and 1500 micrometers, or as raw cellular material, both bleached and unbleached. Raw cellular material requires a suitable fraying in order to achieve a largely homogeneous distribution in the batter.

In many cases it is desirable to add non-fibrous fillers to the batter instead of or in addition to the abovementioned fillers.

Such fillers have no primary structure forming function. However, because of their hardness, for example, they can have a hardening or stiffening effect due to their binding in the starch matrix, or because of a specific interaction with starches. In the same way, stretching of the batter or a

stabilizing effect on the structure of the batter and the molding is considered as a goal of the application.

The examples of such fillers presented earlier in the definition of the invention and in the following recipes are representative of the multiplicity of known fillers and strengtheners. Carbon found in the form of graphite, soot, activated carbon, and carbon fibers is used.

Silica gel as precipitated SiO_2, quartz powder, and chemically converted materials like glass powder, glass fibers, silicates, kaolin, talcum, and mica are used.

The albumin materials used primarily affect the impact behavior and texture of the batters due to their surface active effect, and in addition they exhibit positive influences on the uniform pore structure of the molding.

The adjustment of the product moisture level described in step 3) for the manufacture of the product mentioned above can be assisted by the use of moisture retention agents that are well known in other areas, which affects the regulation and maintenance of this moisture level.

The color of the packaging product, which is originally determined by the color of the raw material and possible effects of the baking process is modified by the combination of dyes, pigments, or fillers that can be distributed in a soluble or homogeneous manner in aqueous media. In the latter case, an effect on the surface condition and specific weight of the product is produced in a well-known manner (see recipe examples 53-59).

1. Inorganic colored pigments:

   The concentration of the pigment can be up to 10 wt.%, and preferentially up to 7.5 wt.%.

2. Dyes:

a) Natural dyes with high coloring power;
water soluble natural dyes are preferred, such as Annato (Bixin), chlorophyll, chlorophyllin, karmesin, paprika oleoresin.

The concentration as a function of the coloring power of the preparation preferentially lies below 0.1 wt.%.

b) Soot, carbon;
activated carbon is used as a colorant in concentrations of 0.0001 - 1 wt.% for gray tones. Higher dosages have already been described as fillers.

c) Synthetic dyes with high coloring power are preferentially food dyes, and in particular, water soluble dyes. The concentration lies below 0.1 wt.%.
Typical dyes in this group are, for example, yellow orange 5, erythrosin I, indigo blue I, fast green FCF, Allura red 40, patent blue AE.

d) Caramel and cocoa powder are mentioned as additional colored organic materials which are, in particular, foods and food additives.

In practice, annato, chlorophyll, and activated carbon are frequently used.

In order to improve product stability, a combination of antioxidants and preservatives are indicated (see recipe examples 33, 34).

Preferred preservatives that are effective in the neutral and weakly acidic pH range for the application with materials allowed in foods include PHB ester, concentrations of 0-0.25 wt.%, p-hydroxybenzoic acid-methyl, -ethyl, propyl esters or their alkalai salts, as well as antioxidative materials used with materials allowed in foods include particularly esters of gallic acid

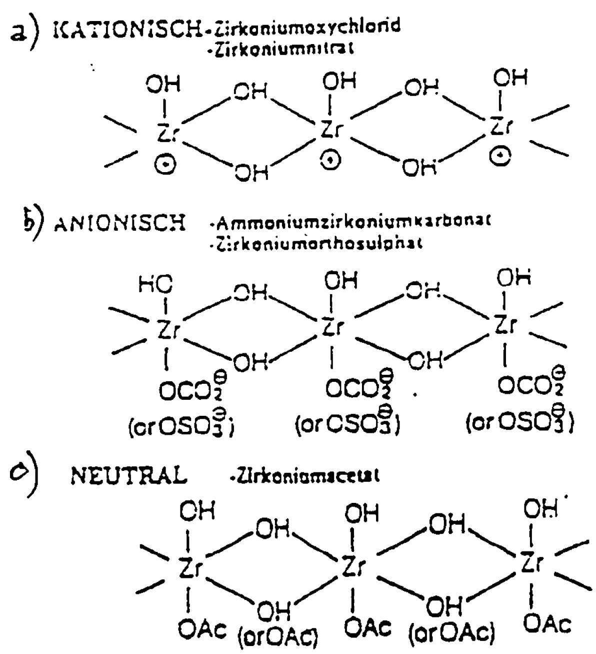
Concentrations 0-0.5 wt.%, and preferentially 0-0.1 wt.%.

All conventional materials used in the production of packing materials for foods can be used at will.

In order to stiffen the structure of the molding to be fabricated, zirconium compounds can also be added to the batter according to the procedure of the invention.

Zirconium in its preferred oxidation state as Zr(IV) exhibits a strong tendency toward coordination with ligands, due to its small ionic radius. These hydrates have a polymeric structure in an aqueous medium. Their size and charge depends on the zirconium concentration, pH value, and the type and concentration of other ions present.

A schematic representation of possible structures and charge states is shown in the following diagram.



Key: a) CATIONIC - zirconium oxychloride, zirconium nitrate

b) ANIONIC - ammonium zirconium carbonate, zirconium orthosulfate

c) NEUTRAL - zirconium acetate

Increasing dilution or an increase in the pH value will cause an increase in the polymer size due to an increase in hydroxy bridges until the zirconium hydroxide precipitates. The amount of this hydrolysis can thus be affected. Zirconium has a high affinity for oxygen-containing species and ions, which control the condition of the zirconium species in solution. In particular, oxygen-containing groups on organic polymers, such as starches, also enter into reactions.

Ammonium zirconium carbonate and its formulation stabilized with tartaric acid (Bacote 20, Magnesium Elektron) are particularly effective as an aqueous solution with pH values of 9.5. The anionic zirconium polymers with ammonium cations that are present in solution are stabilized by the carbonate, but they precipitate during drying and crosslink with hydroxyl groups of the starch. The reaction rate is increased under alkaline conditions, and significantly reduces the concentration required for crosslinking (calculated as ZrO_2).

This can be shown by experiments with various zirconium compounds.

1. zirconium oxide chloride (5 g in 100 g ethanol)
2. zirconium propionate (4 g in 100 g ethanol)
3. zirconium carbonate (5 g in 0.1% acetic acid)
4. zirconium carbonate, solid, pulverized
5. zirconium propionate, solid, pulverized
6. ammoniumzirconium carbonate solution (20% ZrO_2), pH 9.5 (AZC, Magnesium Elektron)
7. Azc -solution as in 6, stabilized with tartaric acid (Bacote 20, Magnesium Elektron)

Recipe No. 76 is used as the basis for these various experimental additives. A variety of Zr-salts is added. The following data on effectiveness relate to the comparability due to the ZrO_2 content.

Results:

to 1. slight rigidification from 0.04 wt.% ZrO_2

to 2. slight rigidification from 0.06 wt.% ZrO_2

to 3. slight rigidification from 0.05 wt.% ZrO_2

to 4. no rigidification

to 5. no rigidification

to 6. slight rigidification from 0.005 wt.% ZrO_2

to 7. slight rigidification from 0.005 wt.% ZrO_2

It is shown from the experiments that under alkaline conditions with the reagents named in 6 and 7, preferred moldings can be produced with a particularly rigid structure (presence of anionic polymer species in the reagent). The concentration range of 0.01 - 0.03 wt.% ZrO_2 is considered to be preferred for the molding recipes described here. Higher dosages are not excluded in principle, but they lead predominantly to degrees of rigidification that no longer allow troublefree shaping. The preferred baking temperature for moldings made with Zr-compounds lies between 180 and 210 degrees C.

Surprisingly, it was determined that the polymethyl hydrogen siloxanes mentioned earlier in connection with the separating agent also increase the rigidity of the molding produced according to the invention.

The formation of the structure of moldings is based essentially on the agglutination of the starch. If insufficient water is available, the agglutination comes to a stop. It has now been shown, surprisingly, that moldings can be made with higher weights, not only with materials that are capable of flowing and are pastose-doughy, but even with raw material mixtures that are no longer cohesive, but are powdery-clumping in nature.

Here the amount of water lies in the lower portion of the region under consideration. Equivalently, there is an increased use of stronger raw materials, as well as non-starch components. This

starch-enriched raw material component can be up to 69.0 wt.%. For example, it is advantageously up to 49.5 wt.% for wheat flour and 49.1 wt.% for cornstarch.

As has already been mentioned, the agglutination of the starch is the main reason for the stable structure of this molding. The starch resulting from the starch-enriched raw material agglutinates during the heating and drying stages. Additional non-starch components (NSC) are included in the recipes in these structures under development. These NSCs are a rigid, essentially homogeneously distributed component of the space structure of the molding due to the thorough mixing of the raw material before placing it into the form and/or due to its own specific shape and condition (e.g., fiber structure, porosity, structured surface, chemical affinity for non-covalent interactions).

In the use of such NSCs, effects that weaken the rigidity occur, which arise both from dilution of the crosslinking starch (filler effect), as well as structure rigidifying effects (binder effects), such as occur with fibrous materials or components that give rise to crosslinking.

The use of NSCs is also limited by:

- a possible toxicity. This means that NSCs must not produce dangerous materials or damaging effects when used for moldings, as well as during their proper postprocessing or evaluation.
- In their concentration stated above, due to the dilution effect already discussed for the structure-forming starch.
- An influence on the manufacturing process according to the invention by suppression or undesirable modification of the reactions taking place.

A series of NSCs are introduced into the recipes. The following are incorporated into individual recipes in concentrations greater than 1% of non-starch dry materials:

- separating agents
- thickeners
- moisture retention agents
- raw materials rich in cellulose
- fillers

A number of additional examples could be added to the group of materials having purposes that can be precisely determined in the manufacturing process (such as in the case of the first three agents mentioned above) and the last two agents which have a filling or binding effect, as discussed above.

calcium carbonate	0.1 - 17.2 wt.%, preferentially 0.4-13.2 wt.%
talcum	0.1 - 12.5 wt.%, preferentially 0.4-9.5 wt.%
acetylated cellulose	0.1 - 14.1 wt.%, preferentially 0.4-11.7 wt.%
aluminum oxide	0.1 - 12.5 wt.%, preferentially 0.4-9.5 wt.%
activated carbon	0.1 - 12 wt.%, preferentially 0.4-8.4 wt.%
shellac	0.1 - 5 wt.%, preferentially 0.4-3.5 wt.%

with respect to the dry ingredients in the batter.

The materials mentioned here are used in powder form. Activated carbon is incorporated well into the starch matrix, and positively affects its molding behavior as well as shape stability during wetting, due to its porous surface structure. The requirements placed on activated carbon result, on the one hand, from the abovementioned toxilogical considerations, such as restricting the amount of inorganic components or zinc, depending on the purpose of the application. Grain sizes smaller than 150 micrometers have proven to be best suited for an optically homogeneous distribution. Granulated activated carbon (sieve fraction 0.125 - 0.5 mm) leads to clearly separated particles that are optically visible in the structure of the molding, but cannot be completely excluded for this reason. A special activation state or porosity of the carbon, as well as restrictions on the production from certain raw materials, are not required.

Shellac is a hard, tough, and amorphous resin with good adhesive and abrasion properties. The application of shellac to the raw material mixture leads to rigidification of the molding because of the film-forming and adhesive properties.

The porosity of well-known products made by baking can be achieved by various procedures which include in principle a relaxation of the batter, or relaxation processes that occur during baking. In most cases, both principles are used. The most important relaxation processes are:

- mechanical relaxation, which is produced by forcing air into the material
- chemical relaxation caused by so-called rising agents
- physical relaxation, such as relaxation due to steam

In the manufacture of comparable thin-walled products like waffles, the relaxation principle is steam relaxation (see W. Seibel et al.: Grains, flours, bread 32, 188, 1978). Rising is not common in the waffle batter.

However, it has surprisingly been shown that in spite of the large volume of steam flowing through the molded body, giving rise to its structure during the baking process, a mechanical relaxation of the batter leads to uniform, fine-pore materials, and contributes to the troublefree production of the molding itself in complicated details of the formation process.

In order to manufacture moldings having a large number of air pores, i.e., with a strengthened foamlike structure, the following is necessary:

1. The introduction of air or other gases by stirring, beating, or (mechanical) pressure, or chemically by the release of relaxation gases (CO_2, ammonia).

2. The presence of materials that are effective in the wall region of the pores that are built into the structure and assure its stability. (Example: sugar and chicken albumin).

Various kinds of albumin, such as chicken albumin, soy albumin, and various milk albumin materials are well suited to forming this wall structure

For this purpose, the following albumin materials are introduced individually or in combination into the batter (amounts given in wt.% of dry ingredients in the batter).

casein	0.1 - 2.6%, preferentially 0.2 - 1.3%
sodium caseinate	0.1 - 1.3%, preferentially 0.2 - 1.0%
soy isolate	0.1 - 2.6%, preferentially 0.2 - 1.7%
chicken albumin	0.1 - 1.7%, preferentially 0.2 - 1.0%

In order to increase the pore stability up to the point where the batter is used, or to assure [stability] over a longer standing time, or to achieve an even finer pore structure, rising emulsifiers are used. Rising agents that are intended to assure higher stability and higher volume of the foam generated thus contain emulsifiers made of monoglycerides and their esters, polyglycerine esters, propylene glycol esters, or sorbitan esters, or their mixtures (Examples: Spongolit, Grünau; Delipan, Bender & Co.) along with the abovementioned albumin components and fillers or vehicles (Sorbit, Maltodextrin, starach).

The batter for the procedure according to the invention is produced as follows:

Water soluble components and powdered minor ingredients are stirred into the required amount of water with vigorous mixing. It is recommended that a dry pre-mixing be carried out, especially for the thickening and separating agents, possibly with the inclusion of 5 wt.% of the starch or flour component, in order to prevent clump formation or problems caused by crosslinking of the separating agent. Then the flour or starch component is stirred in until a homogeneous suspension results. Finally, the separating agent or the fat (in the case of the comparative examples) are mixed in the liquid state.

The batters are adjusted by the addition of water, preferentially to a viscosity between 500 and 3000 mPas, depending on the recipe. Batter temperatures between 12°C and 26°C are achieved, depending on the starting temperatures of the raw materials and surroundings.

The baking process can be carried out under the conditions used for baking edible waffles (these are products that have been thoroughly discussed in the introduction to the description), especially when flours are used as the starch component. However, it is advantageous and desirable that changes be undertaken in two directions:

1. during the slow baking process after pouring the batter
2. during the time/temperature development of the baking process

Re: 1. Slow baking process

The single or multiple rising and sinking of the upper half of the baking mold ("luffing"), depending on the amount of batter added before closing the baking mold, is advantageously is advantageously used for (1) the final filling of the mold, and (2) baking the product.

Here the following processes take place with the associated positive effects described.

1.1 The batter which is poured into the baking mold in a thick layer within a spatially limited region can be spread over a wider area into a thinner layer corresponding approximately to the final product thickness by the sinking of the upper half of the baking mold, and undergoes an initial heating process.

1.2 A release of steam is associated with this heating which can escape directly during the subsequent lifting motion without being diverted through steam escape apertures. This produces faster drying with the following consequences: shortened baking interval and higher material density or product rigidity.

1.3 It produces a "metered" distribution of the batter in the form, having the following positive consequences. After the initial distribution during the sinking process, and the subsequent heating, a stepwise filling of the mold takes place during the subsequent closing processes through the development of steam. However, due to the intermediate lifting and expulsion of steam, this is smaller than for the case of immediate closure. This slower filling of the mold can be "metered" by controlling the intervals for sinking and rising, as well as the number of these motions. An improved formation of the details of the baking mold and a problem free surface for the product can thereby be achieved.

The following ranges have been demonstrated to be desirable:

	Time
sinking baking mold	0.3 - 3 sec, preferentially 0.4 - 0.6 sec
lifting baking mold	0.3 - 10 sec, preferentially 0.4 - 0.7 sec
width of opening	1 - 10 mm, preferentially 1 - 4 mm

Re: 2. Time/temperature development

The baking process requires a minimum energy consumption that is determined essentially by the energy requirement for heating and steam formation of the water contained in the batter. This energy consumption can take place through the temperature of the baking mold and over the residence time in the mold. The temperature setting (between 145 and 225°C), and the baking time (between 40 and 230 sec) can thus not be independently selected; lower temperatures require longer preparation times, and vice-versa.

In connection with the primary production step, namely baking of the product, the desired texture is achieved by a conditioning process with an adjustment of the water content of the product: tough, rigid, and with the desirable deformation capabilities and mechanical stability.

The lower limit of the water content is set at approximately 6 wt.%. Below this, the product becomes increasingly brittle, and the mechanical stress capacity drops.

The upper limit of the water content is determined to be advantageously 16 wt.%, in order to safely exclude the possibility of any type of microbial growth.

A moisture conditioning of up to 22 wt.% is possible by combining with preservatives that are common in the packaging industry.

The conditioning is performed in a well-known manner in batch process climatic chambers or in continuous processes. Cold and hot steam processes, as well as vaporization with ultrasound, can be used, in which it is necessary to assure that there is no formation of moisture films on the surface of the product, and that the water uptake does not exceed 22 wt.%. Too much humidification leads to a weakening of the structure and a deformation of the product.

The procedure for manufacturing moldings according to the invention is based on the application of an essentially isotropic batter into heated baking molds. Both the components essential for forming the structure, as well as all types of additives, fillers, and auxiliary materials, are uniformly distributed throughout the batter.

These moldings can also be produced as a material combination in which prepared and preformed materials that are generally flat and possibly fibrous are incorporated into the resulting structure during the baking process. Manufactured products can also be used as the flat materials according to the procedure of the invention.

An initial assumption for this is that the materials to be incorporated must be included at the latest at a point in time before the final closure of the mold at a predefined point on the mold in a well-defined sequence to become embedded in the batter of the underlying body (see examples), so that this introduction occurs before any possible luffing process is carried out.

The second assumption for the use of such flat or fibrous materials is that their stability must be guaranteed with respect to melting at the baking temperatures used.

Third assumption: The application of flat or fibrous materials must correspond to the maximum clearance of the baking mold at its thickest point, or must be compressible to this thickness.

The limitation in mechanical handling capability or manufacturability of suitable materials (foils) is low. The 12 micrometer thick foil used in the examples thus does not represent a lower limit.

Examples of such materials are:

1. Foils or sheets:

   Paper, cardboard of any type, i.e., materials essentially made of fibrous materials, and predominantly of cellulose. These papers can be colored, pressed, or specially treated.

   Plastic, polyethylene terphthalate and other temperature-stable materials

   Aluminum

   Fleeces or mats, fibers

   Fibrous materials made of glass, plastic, metal, natural fibers (e.g., bast fibers, cotton, straw, etc.), possibly linked into fleeces or mats in a more or less regular manner.

The binding of the abovementioned materials into the underlying body occurs during its manufacture by baking at temperatures between 145 and 225°C under the following prevailing conditions: pressure peaks up to approx. 2.5 bar, release of a large volume of steam, agglutination of the basic starch material.

The adhesive and binding effect of the inserted flat or fibrous materials is sufficient for the applications envisioned for the molding thus equipped (e.g., plates, cups, goblets, trays, inserts, carriers, rods, spatulas, and related objects), and is not related to the presence of adhesives or other adhesive or binding agents, but rather is based on the adhesive effect occurring under the manufacturing conditions described here as a function of the surface condition of the incorporated materials (~~roughness, porosity~~).

The principle of the procedure will be explained in a non-limiting manner with the aid of the examples to be presented.

I. Formation of a connection of molded pieces to make a flexible joint.
Fig. 1 is a schematic diagram showing the formation of a flexible joint between two moldings.

The formation of such a flexible joint is not limited to

1. the connection of similar molded components (identical in shape, size, color, and material composition).

2. the use of a single piece or strip to be inserted.
The connection can likewise be formed by a plurality of strips, bands, or string-type inserts.

3. the introduction of a component already sized to its proper final dimension before the baking process. The incorporated material can extend out [of the object] and this extension, which can possibly form a connection to neighboring materials [or] bonded objects is only separated after the manufacturing process.

The flexible joint material is fixed in its position by closing the baking mold. It is then crosslinked by the batter in the areas provided, and/or the batter flows around it and binds it into the underlying molding during the baking process.

An embodiment of a product manufactured according to the invention is shown in the attached diagrams. The diagrams show a baked molding for a hinged container consisting of two identical container halves attached to one another with a hinge. Fig. 1 shows a top view on the baked molding as it is removed from the container baking mold. Fig. 2 shows a cross section through the molding of Fig. 1. Fig. 3 shows the enlarged region of the band hinge. Fig. 4 shows the band hinge in a closed condition for both halves of the container, i.e., for a closed hinged container. Fig. 5 shows one part of the closed hinged container from the outside.

The baked molding consists of two container shells 1,2 that are open at the top and identical with one another, which form a closed hinged container when folded together. Both of the container shells 1,2 are connected at their neighboring edges 3,4 by a band hinge 7 formed in recesses 5,6, which consist of a flat material, e.g., a band, baked together with the two container shells making up the underlying body. In order to prevent an opposing displacement of the two container shells in the closed positioin, the front sides of the sidewalls of the container shells 1,2 that are brought adjacent to one another are provided with projections 8 and depressions 9 that can be engaged with one another. Variants of the embodiment are described in examples 7 to 9. Under the assumptions already mentioned with regard to the condition of the flat materials bonded with the underlying body, the inner and outer side of the resulting moldings are covered by this piece.

Based on the development of steam occurring during the baking process, it results that

1. flat materials that have been placed centrally with respect to the entire outer surface (lower surface) of the underlying body are bonded at the prescribed position and lie on the outer side with sharp edges, without being surrounded by batter. The only requirement for this is that the batter be introduced from the center.

2. Flat materials that are not centrally located with respect to the metering of the batter, and are thereby subjected to steam development, undergo a displacement, and are not bonded at a predefined point.

3. The comments made in 1 and 2 are valid in principle for the internal surface (upper surface) of the underlying body, with the exception that the metering of the batter occurs before placement of the flat material.

However, it is surprising that the bonding of flat materials can include the entire upper or lower surface of the underlying body, or even both surfaces, considering the baking process used in its production.

No problems occurred in the experiments described in examples 10 to 24, either with the thorough drying or with the surface formation. This could have happened due to the altered heat transfer relationship caused by coating of the surfaces with poorly conducting materials.

A suitably large piece of flat material was placed in the baking mold before or after adding the batter or both before and after adding it, so that the upper and/or lower surface is partially or completely coated after closing the baking mold, or an excess length of flat material results.

Very smooth and high tensile strength materials, such as polyethylene terphthalate foils can even be pulled out of the body after baking without damage, but residuals of the adhering underlying body material visible with an electron microscope and an [optical] microscope, as well as with the unaided eye, can be seen. This was documented with a scanning electron microscope, and produced evidence for an intense interaction in the bonding of smooth, flat materials.

The unexpected troublefree finishing of such upper and lower side partial or fully coated material combinations in this case is also not related to the molding recipe disclosed here. Note that example 13 is approximately the same as a recipe used for making waffles.

In cases of completely flat upper and lower side coatings of the underlying body, new types of products can be manufactured insofar as the various limitations understood from the production of edible waffles and similar baked goods are not applicable.

These concern:

1. Adhesion to the baking mold, caused by low molecular weight carbohydrates (e.g., sugar, syrups, polyoils) which result in especially hard structures (see Example 18 with sugar) after completion, depending on the material and concentration, or can be used as moisturizing or softening agents like glycerine.

2. The use of fats, oils, and emulsifiers, like lecithin for example, in their function as mold separating agents.

3. Special problems with the rapid oxidative degradation of baked goods, primarily due to the distribution of the fats mentioned in 2 over large porous surfaces.

4. Contamination of the baking molds caused by residual materials remaining after removal [of the object] from the form, which build up during the course of repeated baking cycles.

For example, in Examples 19 and 20 taken from waffle production, well-known recipes are used without fats and lecithin. Continuous production without these additives, especially for increased concentrations of low molecular weight carbohydrates (Example 20) cannot be carried out without covering the upper and lower surfaces of the product as described.

TEST METHODS

1. UV test

Principle: Irradiation of the samples with UV light (wavelength 366 nm) with attached sensor detection.

Equipment: CAMAG UV-cabinet, sample distance from filter glass 80 mm,
Duration of irradiation 25 hours.

Oxidative modifications of fats occur through radical reactions. It is possible to induce such reactions very rapidly by photooxygenation. For this reason, fat oxidation can be produced very rapidly by UV irradiation of fats or fat-containing samples. Only in the absence of fats or for fat concentrations that do not exceed the smell threshhold for rancid smelling decomposition products are no modifications in the smell detectable in the UV test.

The UV test is thus a sensitive fast proof of the presence of lipids, which can lead to negative sensory modifications of the molding for long-term storage subject to light and/or oxygen from the air, depending on their type or concentration.

Evaluation: Sensory judgement based on odor modifications

1	no negative odor noticed
2	very slight rancid/burned/moldy odor
3	slight rancid/burned/moldy odor
4	rancid/burned/moldy odor
5	obvious rancid/burned/moldy odor

The taste evaluation analogously focuses on the rancid/burned/musty rating scheme.

UV test passed: Evaluation no higher than 3

2. Storage test

Sensory evaluation at 2-week intervals

Evaluation: Sensory judgement based on modifications in smell and taste

1	no negative smell impression
2	very slightly rancid/moldy
3	slightly rancid/moldy
4	rancid/moldy
5	obviously rancid/moldy

Storage test passed:

Evaluation after 2 weeks no higher than 1

Evaluation after 6 weeks no higher than 2

3. Evaluation of shaping

Shaping as used here is to be understood as the precise formation of the shape of the molding as given by the baking mold.

Deforming, i.e., release of the molding from the baking mold at the end of the baking process, is considered in the individual recipes under the term "adhering". "Adhering" occurs when parts of the molding remain in the baking mold due to baking of the molding, or the visible formation of baking residuals even after single baking processes.

A possible formation of cracks in the molding, e.g., tension cracks caused by temperature or moisture, is not intended with the terms "adhering" or "shaping".

1	all details are well shaped
2	good shaping, individual details on exposed positions are not completely shaped
3	well shaped in all essential regions, individual defects
4	obvious shaping defects
5	poorly shaped

Shaping test: Evaluation 1 - 3: passed (+ in table)
Evaluation 4 + 5: not passed.

LUFFING BEFORE CLOSING THE MOLD

	A	B	C	D	E	F	G	H	J
OPEN time, sec	0,4	0,3	0,6	0,6	0,7	0,6	0,5	1	0,5
CLOSED time, sec	0,6	0,6	0,3	0,3	0,6	0,4	0,5	0,4	0,5
Number	5	10	5	10	5	20	4	20	1
Lift height, mm	3	3	3	3	4	1	10	5	6

CONDITIONING

Condition:	K1	K2	K3	K4	K5
Temperature, °C	59	59	26	26	45
relative humidity, %	58	58	81	86	82
time, min	30	60	70	210	30
water content, %(+/- 20 wt.%)	7,5	11	16	21	9

The indicated water contents (7.5 wt.%, 11 wt.%, etc.) are average values that are subject to scattering from piece to piece, and are also affected by the recipe and wall thickness of the respective moldings.

A bandwidth of at least ± 20 wt.% for the water content was thus indicated, i.e., for example, 7.5 ± 1.5 wt.%.

The maximum water content of 22 wt.% must never be exceeded.

Texture testing

The baked and conditioned moldings are tested with the aid of a test device

STRUCTOGRAPH, Brabender OHG Duisburg,

2 kp test specimen, 1000 scale divisions correspond to a force of 2 kp (19.6 N)

Test body: cylinder-bar, diameter 6.00 mm

Test sample: wall thickness 2.0 mm, ribbing 8 x 8 mm

Test sample L (water content 8.3 wt.%, Recipe No. 11):
Force required for perforation: 750 scale divisions, no breakage, sample remained intact

Test sample K (water content 11.1 wt.%, Recipe No. 11):
Force required for perforation: 680 scale divisions, no breakage, sample remained intact

The texture test is a measure of the rigidity of the product with respect to penetration (perforation) of the molding by a force applied at a 90° angle with respect to the surface of the body.

Several typical measured values

crisp waffles:	force required 200 - 280 scale divisions The test specimen is brittle, has practically no elastic or plastic component, and breaks even with a force below 450 scale divisions (corresponding to 8.8 N) into many small pieces.
molding material:	8.3% water, Recipe No. 11 The test specimen is already plastic/elastic, but still has slight brittle components that increase the amount of force required.

The required force is still about 10 wt.% higher than for products conditioned to a higher moisture level, due to these brittle structural components.

The latter products (11.1 wt.% water content) can be bent to a 90° angle without breaking. This property increases with increasing water content.
The production of bendable or foldable moldings is thus dependent on:

1. The fabrication of thin sheet type structures having typical wall thicknesses of 0.5 to 1.5 mm, and preferentially below 1 mm, possibly with baked-in folding grooves.

2. The maintenance of water contents in the range of 10 to 22 wt.%, and preferentially 12 to 20 wt.%, or

3. The single or double sided lamination of the molded material with flexible coatings, which can consist of plastic materials like polyethylene or also plastics or natural materials having rubbery elastic properties for example.

Comparative waffeling measurement:	The breaking force required lies below 450 scale divisions, and preferentially below 250 scale divisions.

Product examples

Example 1:

FAST FOOD PACKAGING

pyramidal truncated container shells with rounded corners and edges

Format:	130 x 128 mm, height 40 mm
Wall thickness:	1.8 mm with formed ribs and straps 2.4 mm
Baking temperature:	160°C (outer form) 165°C (inner form)

[end of translation]

EXAMPLE 2:
PACKAGING INSERT

Low, dish-shaped container with reinforced top edge and several dished individual compartments

Size: 186 x 64 mm, height 17 mm

Wall thickness: 1.8 mm
2.0 mm at top reinforced edge

Baking temperature: 185°C

Baking time: 45 sec.

Filling time: 1.8 sec.; closure time 1.2 sec.

Recipe Nos. 11 through 18 and 45-59; test assessment as described above

Example 3:

TUB

Total height: 80 mm
Diameter: 55 mm bottom
Opening: 85 mm top
Wall thickness: 1.8 mm
top wall reinforcement 2.0 mm

Baking temperature: 170°C (outer mold)
190°C (inner mold)

Baking time: minimum 43 sec. (Test 19)
maximum 70 sec. (Test 23)

Filling time: 2.3 sec.; closure time: 1.2 sec.

Recipe Nos. 19 through 27

Example 4:

ROUND PLATE

Height: 12 mm
Diameter: 150 mm
Wall thickness: 2.0 mm - 2.2 mm

Baking temperature: 185°C

Baking time: 65 sec.

Filling time: 1.9 sec.; closure time 1.2 sec.

Recipe Nos. 27 through 44; test assessment as described above

Example No. 5:

Flat sheet with honeycomb pattern on both sides

Size:	290 x 460 mm
Total thickness:	4.1 mm
comprising	0.3 mm embossments on underside
	2 mm distance between embossments
	1.8 mm core thickness
	2.0 mm embossments on top side
	8 mm distance between embossments

Automatic filling; filling time 1 sec.

Baking temperature 175°C, baking time 100 sec., recipe No. 11

Example No. 6

Flat cup

Size: 135 x 185 mm with rounded corners and raised edge on all sides

Wall thickness: 2.0/2.2 mm

Manual filling

Baking temperature 190°C, baking time 90 sec., sample recipe Nos. 60-70

Example 7

Baked molding for hinged container--2 halves with external dimensions of 130 x 125 x 40 mm forming a mirror-image of each other beginning at the center of the hinged side joining the two sections (Fig. 1).

Composition of base molding: Recipe No. 109

Composition of flat material: wood-free, dull-finish white paper, 80 g/m^2
Strips, 80 x 20 mm, creased lengthwise down the middle

Sequence: Step 1 Place the paper strip into the non-porous

	bottom half of the baking mold
Step 2	Place the mixture into the depressions in the bottom half of the baking mold
Step 3	Close the baking mold
Step 4	Bake to form the material composite
Step 5	Remove the baked container
Step 6	Conditioning at 15°C, 76% relative humidity, 145 min.

Examples 8 and 9

Baked molding for hinged container--2 halves with external dimensions of 130 x 125 x 40 mm forming a mirror-image of each other beginning at the center of the hinged side joining the two sections (Fig. 1).

Composition of base molding: Recipe No. 109

Composition of flat material:

Example 2	Textile-based nonwoven fabric, cotton/cellulose, 110 g/m², 80 x 35 mm, pre-folded in longitudinal direction
Example 3	Nonwoven fabric, fiberglass, 31.5 g/m², 80 x 35 mm, pre-folded in longitudinal direction

Sequence same as Example 7.

Example 10

Baked molding for hinged container--2 halves with external dimensions of 130 x 125 x 40 mm forming a mirror-image of each other beginning at the center of the hinged side joining the two sections (Fig. 1).

Composition of base molding:

Wheat flour	100
Powdered milk	1.5
Baking soda	0.3
Salt	0.5
Fat	2
Lecithin	05.
Water	150

Composition of the flat material: wood-free, dull-finish white paper, 80 g/m²
Strips, 80 x 20 mm, creased

lengthwise down the middle

Sequence: Step 1 Place the paper strip into the non-porous bottom half of the baking mold
Step 2 Place the mixture into the depressions in the bottom half of the baking mold
Step 3 Close the baking mold
Step 4 Bake to form the material composite
Step 5 Remove the baked container
Step 6 Conditioning at 15°C, 76% relative humidity, 145 min.

Example 11

Baked molding for round plate with the following dimensions: 150 mm diameter, 12 mm total height, 2.0/2.2 mm wall thickness. Temperature: 185°C; baking time 80 seconds.

Composition of base molding: Recipe No. 109

Composition of the flat material: prefabricated material for moldings (recipe No. 109 with addition of 0.05 percent by weight activated charcoal); wall thickness 1.1 mm, smooth sheet cut into a flat disk with a 62 mm diameter

Sequence: Step 1 Place the mixture into the depression in the bottom half of the baking mold
Step 2 Center the disk over the mixture
Step 3 Close the baking mold
Step 4 Bake to form the material composite
Step 5 Remove from mold
Step 6 Conditioning at 15°C, 76% relative humidity, 145 min.

Result: Flat material is completely integrated into the top side of the molding produced. The underside of the flat material is completely bonded to the molding while the top side of the flat material is exposed.

Example 12

Baked molding for round plate with the following dimensions: 150 mm diameter, 12 mm total height, 2.0/2.2 mm wall thickness. Temperature: 185°C; baking time 80 seconds.

Composition of base molding: Recipe No. 109

Composition of the flat material: paper, 80 g/m^2 wood-free, white, dull finish, flat disk, 100 mm diameter

Sequence: Step 1 Place the mixture into the depression in the bottom half of the baking mold
Step 2 Center the disk over the mixture
Step 3 Close the baking mold
Step 4 Bake to form the material composite
Step 5 Remove from mold
Step 6 Conditioning at 15°C, 76% relative humidity, 145 min.

Result: Flat material is completely integrated into the top side of the molding produced. The underside of the flat material is completely bonded to the molding while the top side of the flat material is exposed.

Example 13

Baked molding for round plate with the following dimensions: 150 mm diameter, 12 mm total height, 2.0/2.2 mm wall thickness. Temperature: 185°C; baking time 80 seconds.

Composition of base molding: Recipe No. 109

Composition of the flat material: cotton/cellulose woven fabric, white with blue lines, basic weight 110 g/m^2, flat disk, 100 mm diameter

Sequence: Step 1 Place the mixture into the depression in the bottom half of the baking mold
Step 2 Center the disk over the mixture
Step 3 Close the baking mold
Step 4 Bake to form the material composite
Step 5 Remove from mold
Step 6 Conditioning at 15°C, 76% relative humidity, 145 min.

Result: Flat material is completely integrated into the top side of the molding produced. The underside of the flat material is completely bonded to the molding while the top side of the flat material is exposed.

Example 14

Baked molding for round plate with the following dimensions: 150 mm diameter, 12 mm total height, 2.0/2.2 mm wall thickness.

Temperature: 185°C; baking time 80 seconds.

Composition of base molding: Recipe No. 109

Composition of the flat material: fiberglass nonwoven fabric, basic weight 31.5 g/m^2, flat disk, 100 mm diameter

Sequence:
- Step 1 Place the mixture into the depression in the bottom half of the baking mold
- Step 2 Center the disk over the mixture
- Step 3 Close the baking mold
- Step 4 Bake to form the material composite
- Step 5 Remove from mold
- Step 6 Conditioning at 15°C, 76% relative humidity, 145 min.

Result: Flat material is completely integrated into the top side of the molding produced. The underside of the flat material is completely bonded to the molding while the top side of the flat material is exposed.

Example 15

Baked molding for round plate with the following dimensions: 150 mm diameter, 12 mm total height, 2.0/2.2 mm wall thickness. Temperature: 185°C; baking time 80 seconds.

Composition of base molding: Recipe No. 109

Composition of the flat material: polyethylene terephthalate (PET) film, film thickness 12 micrometers, flat disk with 100 mm diameter

Sequence:
- Step 1 Place the mixture into the depression in the bottom half of the baking mold
- Step 2 Center the disk over the mixture
- Step 3 Close the baking mold
- Step 4 Bake to form the material composite
- Step 5 Remove from mold

Result: Flat material is completely integrated into the top side of the molding produced. The underside of the flat material is completely bonded to the molding while the top side of the flat material is exposed.

Example 16

Baked molding for round plate with the following dimensions: 150 mm diameter, 12 mm total height, 2.0/2.2 mm wall thickness. Temperature: 185°C; baking time 80 seconds.

Composition of base molding: Recipe No. 109

Composition of the flat material: polyethylene terephthalate (PET) film, film thickness 36 micrometers, flat disk with 100 mm diameter

Sequence:
- Step 1 Place the mixture into the depression in the bottom half of the baking mold
- Step 2 Center the disk over the mixture
- Step 3 Close the baking mold
- Step 4 Bake to form the material composite
- Step 5 Remove from mold

Result: Flat material is completely integrated into the top side of the molding produced. The underside of the flat material is completely bonded to the molding while the top side of the flat material is exposed.

Example 17

Baked molding for round plate with the following dimensions: 150 mm diameter, 12 mm total height, 2.0/2.2 mm wall thickness. Temperature: 185°C; baking time 80 seconds.

Composition of base molding: Recipe as for Example 4

Composition of the flat material: paper, 80 g/m^2, wood-free, white, dull finish, flat disk, 100 mm diameter

Sequence:
- Step 1 Place the mixture into the depression in the bottom half of the baking mold
- Step 2 Center the disk over the mixture
- Step 3 Close the baking mold
- Step 4 Bake to form the material composite
- Step 5 Remove from mold
- Step 6 Conditioning at 15°C, 76% relative humidity, 145 min.

Result: Flat material is completely integrated into the top side of the molding produced. The underside of the flat material is completely bonded to the molding while the top side of the flat material is exposed.

Example 18

Baked molding for round plate with the following dimensions: 150 mm diameter, 12 mm total height, 2.0/2.2 mm wall thickness. Temperature: 185°C; baking time 80 seconds.

Composition of base molding: Recipe No. 109

Composition of the flat material: fiberglass nonwoven fabric, basic weight 31.5 g/m², square piece of nonwoven fabric, 200 mm x 200 mm

Sequence:
- Step 1 Place the mixture into the depression in the bottom half of the baking mold
- Step 2 Place the square piece of flat material so that it completely and symmetrically covers the bottom half of the mold
- Step 3 Close the baking mold
- Step 4 Bake to form the material composite
- Step 5 Remove from mold
- Step 6 Conditioning at 15°C, 76% relative humidity, 145 min.

Result: Flat material completely covers the top side (inner side) of the material-composite molding produced.

Example 19

Baked molding for round plate with the following dimensions: 150 mm diameter, 12 mm total height, 2.0/2.2 mm wall thickness. Temperature: 185°C; baking time 80 seconds.

Composition of base molding: Recipe No. 109

Composition of the flat material: special paper for foodstuffs ("baking paper"), basic weight 70 g/m², size 190 x 200 mm

Sequence:
- Step 1 Place the mixture into the depression in the bottom half of the baking mold
- Step 2 Place the square piece of flat material so that it completely and symmetrically covers the bottom half of the mold
- Step 3 Close the baking mold
- Step 4 Bake to form the material composite
- Step 5 Remove from mold
- Step 6 Conditioning at 15°C, 76% relative humidity, 145 min.

Result: Flat material completely covers the top side (inner side) of the material-composite molding produced.

Example 20

Baked molding for round plate with the following dimensions: 150 mm diameter, 12 mm total height, 2.0/2.2 mm wall thickness. Temperature: 185°C; baking time 80 seconds.

Composition of base molding: Recipe No. 109

Composition of the flat material: PET film, film thickness 15 micrometers, size 175 x 210 mm

Sequence:
Step 1 Place the mixture into the depression in the bottom half of the baking mold
Step 2 Place the square piece of flat material so that it completely and symmetrically covers the bottom half of the mold
Step 3 Close the baking mold
Step 4 Bake to form the material composite
Step 5 Remove from mold

Result: Flat material completely covers the top side (inner side) of the material-composite molding produced.

Example 21

Baked molding for round plate with the following dimensions: 150 mm diameter, 12 mm total height, 2.0/2.2 mm wall thickness. Temperature: 185°C; baking time 80 seconds.

Composition of base molding: Recipe No. 109

Composition of the flat material: PET film, film thickness 36 micrometers, size 175 x 210 mm

Sequence:
Step 1 Place the mixture into the depression in the bottom half of the baking mold
Step 2 Place the square piece of flat material so that it completely and symmetrically covers the bottom half of the mold
Step 3 Close the baking mold
Step 4 Bake to form the material composite
Step 5 Remove from mold

Result: Flat material completely covers the top side (inner side) of the material-composite molding produced.

Example 22

Baked molding for round plate with the following dimensions: 150 mm diameter, 12 mm total height, 2.0/2.2 mm wall thickness. Temperature: 185°C; baking time 80 seconds.

Composition of base molding: Recipe No. 109

Composition of the flat material: PET film, film thickness 15 micrometers, size 175 x 200 mm, 2 pieces

Sequence:

Sequence:	Step 1	Place the first piece of film so that it covers the bottom half of the mold
	Step 2	Add the mixture
	Step 3	Place the second piece of film so that it completely and symmetrically covers the bottom half of the mold
	Step 4	Close the baking mold
	Step 5	Bake to form the material composite
	Step 6	Remove from mold

Result: Flat material completely covers the top side (inner side) and the underside (outside) of the material-composite molding produced.

Example 23

Baked molding for round plate with the following dimensions: 150 mm diameter, 12 mm total height, 2.0/2.2 mm wall thickness. Temperature: 180°C; baking time 110 seconds.

Composition of base molding (in parts by weight):

Wheat flour	100
Starch	8
Sugar	1
Powdered egg	2
Baking soda	0.3
Salt	0.5
Water	150
Fat	-
Lecithin	-

Composition of the flat material: PET film, film thickness 15 micrometers, size 175 x 200 mm, 2 pieces

Sequence:	Step 1	Place the first piece of film so that it covers the bottom half of the mold
	Step 2	Add the mixture

Step 3	Place the second piece of film so that it completely and symmetrically covers the bottom half of the mold
Step 4	Close the baking mold
Step 5	Bake to form the material composite
Step 6	Remove from mold

Result: Flat material completely covers the top side (inner side) and the underside (outside) of the material-composite molding produced.

Example 24

Baked molding for round plate with the following dimensions: 150 mm diameter, 12 mm total height, 2.0/2.2 mm wall thickness. Temperature: 180°C; baking time 115 seconds.

Composition of base molding (in parts by weight):

Wheat flour	100
Sugar	42
Powdered egg	2
Baking soda	0.3
Salt	0.6
Water	125
Fat	-
Lecithin	-

Composition of the flat material: PET film, film thickness 15 micrometers, size 175 x 200 mm, 2 pieces

Sequence:	Step 1	Place the first piece of film so that it covers the bottom half of the mold
	Step 2	Add the mixture
	Step 3	Place the second piece of film so that it completely and symmetrically covers the bottom half of the mold
	Step 4	Close the baking mold
	Step 5	Bake to form the material composite
	Step 6	Remove from mold

Result: Flat material completely covers the top side (inner side) and the underside (outside) of the material-composite molding produced.

Example 25: Flat sheet

Size 290 x 230 mm, wall thickness 1.4 mm, smooth surface, baking temperature 180°C, baking time 105 sec.

Recipe No. 116

Result: smooth, fully molded sheets, non-porous surfaces, can be written on and printed

Example 26: Flat cup

Size 135 x 185 mm with rounded corners and raised edge on all sides.

Wall thickness 2.0/2.2 mm

Baking temperature 180°C, baking time 130 sec.

Recipe Nos. 117, 119 - 127

Example 27: rectangular container, conical shape with stacking lip

External dimensions: 142 x 91 mm (top)
112 x 62 mm (bottom)
Height: 42 mm
Wall thickness: 1.8/2.0 mm, embossment 5 x 5 mm, 45 degrees on exterior and interior bottom
Baking temperature 165/180°; baking time 40 sec.
Recipes Nos. 116, 128

Example 28: Dish-shaped container with reinforced top edge and 8 dished individual compartments

Size 106 x 173 mm, height 30 mm
Wall thickness 1.8/2.0 mm; embossment 5 x 5 mm, 45° on interior bottom
Baking temperature 175/190°C
Baking time 50 sec.
Recipe Nos. 116, 128

Example 29: Low, round tub
Diameter 75 mm (top edge)
50 mm (bottom)
Height 30 mm
With beaded exterior design, smooth inner rim with reinforced edge (maximum thickness 4 mm)
Wall thickness 1.5/1.8 mm, in decorative area between 1.2 and 3.2 mm
Baking temperature 180/185°C
Baking time 60 sec.
Recipe Nos. 116, 118

Example 30: Dish-shaped container with reinforced top edge and removable lid and embossments on bottom

External dimensions: top 135 x 171 mm maximum
bottom 115 x 150 mm maximum
height 90 mm

Lid: max. 127 x 164 mm, height 18 mm
Wall thickness 1.8 mm
Baking temperature: 190°C
Baking time: 60 sec.
Recipe No. 116

	Nr. 1	Nr. 2	Nr. 3	Nr. 4	Nr. 5
potato starch	100	100	100	100	100
wheat flour	-	-	-	-	-
water	125	125	125	167	167
thickening agent	0,5(1)	0,5(1)	0,5(1)	-	0,5(1)
material rich in cellulose	10(4)	10(4)	10(4)	20(4)	25(4)
fat	-	5(9)	-	5,7(9)	-
separating agent	-	-	1(5)	-	2,5(6)
other components	-	-	-	-	-
luffing, condition	A	B,C,nein	D	C,nein	C
shaping (a)	+	+,+,-	+	+,-	+
adhering	ja	nein	nein	ja	nein
conditioning	K3	K3	K3	K3	K4
UV test (a)	+	-	+	-	+
storage test (a)	+	-	+	-	+

Key: "ja" = yes; "nein" = no
(a) + indicates: test passed
(1) carboxy methyl cellulose
(2) guar
(3) modified starch
(4) cellulose fibers
(5) aluminum stearate
(6) calcium stearate
(7) magnesium stearate
(8) zinc stearate
(9) coconut oil

	Nr. 6	Nr. 7	Nr. 8	Nr. 9	Nr. 10
potato starch	100	100	100	50	100
cornstarch	-	-	-	50	-
water	150	120	100	110	110
thickening agent	1(10)	1(1)	0,5(11)	0,5(2)	0,3(11) 0,3(2)
material rich in cellulose	10(4)	-	-	-	-
fat	10(12)	-	-	-	-
separating agent	10(7)	10(8)	1(5)	1(5)	1(5)
other components	-	-	-	-	-
luffing, condition	C	E	G	G	C
shaping (a)	+	+	+	+	+
adhering	nein	nein	nein	nein	nein
conditioning	K3	K3	K3	K4	K4
UV test (a)	-	+	+	+	+
storage test (a)	-	+	+	+	+

Key: "ja" = yes; "nein" = no
(a) + indicates: test passed
(1) carboxy methyl cellulose
(2) guar
(3) modified starch
(4) cellulose fibers
(5) aluminum stearate
(6) calcium stearate
(7) magnesium stearate
(8) zinc stearate
(9) coconut oil
(10) sodium alginate
(11) carrageen
(12) hardened fat

	Nr. 16	Nr. 17	Nr. 18	Nr. 19	Nr. 20
potato starch	100	100	100	100	100
water	130	130	130	130	130
thickening agent	0,5(1)	0,5(1)	0,5(1)	0,5(1)	0,5(1)
material rich in cellulose	10(4)	10(4)	10(4)	10(4)	10(4)
separating agent	2(6)	2(6)	2(6)	2(10)	2(11)
other components	5(12)	4(13)	5(14)	-	-
luffing, condition	B	B	B	E	E
shaping (a)	+	+	+	+	+
adhering	nein	nein	nein	ja	nein
conditioning	X1	X1	X1	X2	X2
UV test (a)	+	+	+	n.a.	+
storage test (a)	+	+	+	n.a.	+

Key: "ja" = yes; "nein" = no
(a) + indicates: test passed
(1) carboxy methyl cellulose
(2) guar
(3) modified starch
(4) cellulose fibers
(5) aluminum stearate
(6) calcium stearate
(7) magnesium stearate
(8) zinc stearate
(9) coconut oil
(10) sodium alginate
(11) carrageen
(12) hardened fat
(13) glycerine
(14) sorbite
n.a. not carried out

	Nr. 21	Nr. 22	Nr. 23	Nr. 24	Nr. 25
potato starch	100	100	100	100	100
water	130	130	130	130	130
thickening agent	0,5(1)	0,5(1)	0,5(1)	0,5(1)	0,5(1)
material rich in cellulose	10(4)	10(4)	10(4)	10(4)	10(4)
fat	-	-	-	-	2(9)
separating agent	2(10)	2(11)	2(8)	2(12)	-
other components	-	-	-	-	-
luffing, condition	E	E	E	E	E
shaping (a)	+	+	+	+	+
adhering	nein	nein	nein	nein	nein
conditioning	K2	K2	K2	K2	K2
UV test (a)	+	+(b)	+	-	-
storage test (a)	+	+(b)	+	-	-

Key: "ja" = yes; "nein" = no
(a) + indicates: test passed
(1) carboxy methyl cellulose
(2) guar
(3) modified starch
(4) cellulose fibers
(5) aluminum stearate
(6) calcium stearate
(7) magnesium stearate
(8) zinc stearate
(9) coconut oil
(10) hydroxystearic acid
(11) sodium stearate
(12) lecithin
(b) soapy taste

	Nr. 26	Nr. 27	Nr. 28	Nr. 29	Nr. 30
potato starch	95	100	100	100	100
water	140	150	145	165	150
thickening agent	5(3)	0,5(2)	0,5(2)	0,5(2)	0,5(1)
material rich in cellulose	10(4)	30(10)	29(11)	50(12)	10(13)
fat	10(9)	-	-	-	-
separating agent	1(14)	3,5(5)	3(6)	2(7)	1,5(8)
other components	-	-	-	-	-
luffing, condition	G	G	G	G	G
shaping (a)	(+)	+	+	+	+
adhering	nein	nein	nein	nein	nein
conditioning	K1	K1	K1	K1	K1
UV test (a)	-	+	+	+(b)	+
storage test (a)	-	+	+	+(b)	+

Key: "ja" = yes; "nein" = no
(a) + indicates: test passed
(1) carboxy methyl cellulose
(2) guar
(3) modified starch
(4) cellulose fibers
(5) aluminum stearate
(6) calcium stearate
(7) magnesium stearate
(8) zinc stearate
(9) coconut oil
(10) wheat bran, fine, defatted
(11) straw flour, short fiber
(12) wood flour
(13) cellulose, 1500 micrometer, fibrous
(14) lecithin
(b) unpleasant taste

	Nr. 31	Nr. 32	Nr. 33	Nr. 34	Nr. 35
potato starch	65	85	85	-	75
wheat flour	35	15	15	100	25
water	145	140	140	160	145
thickening agent	0,3(2)	0,4(2)	0,4(2)	-	5(3)
material rich in cellulose	10(4)	10(4)	10(4)	10(4)	10(4)
separating agent	1(5)	1(5)	1(5)	5(7)	1,5(7)
other components	-	-	0,05(10)	0,05(11)	-
luffing, condition	λ	λ	λ	λ	λ
shaping (a)	+	+	+	+	+
adhering	nein	nein	nein	nein	nein
conditioning	K1	K1	K1	K1	K1
UV test (a)	+	+	+	+	+
storage test (a)	+	+	+	+	+

Key: "ja" = yes; "nein" = no
(a) + indicates: test passed
(1) carboxy methyl cellulose
(2) guar
(3) modified starch
(4) cellulose fibers
(5) aluminum stearate
(6) calcium stearate
(7) magnesium stearate
(8) zinc stearate
(9) coconut oil
(10) sodium methyl-4-hydroxybenzoate
(11) dodecylgallat

	Nr. 36	Nr. 37	Nr. 38	Nr. 39	Nr. 40
potato starch	50	50	-	50	40
wheat flour	50	50	100	50	60
water	130	130	160	130	140
thickening agent	0,4(1)	0,4(1)	-	0,4(1)	0,4(10)
material rich in cellulose	10(4)	10(4)	10(4)	10(4)	10(4)
fat	-	2(9)	-	10(11)	-
separating agent	2,5(7)	-	5(7)	-	3(7)
luffing, condition	λ	λ	λ	λ	λ
shaping (a)	+	+	+	+	+
adhering	nein	ja	nein	nein	nein
conditioning	K5	n.a.	K5	K5	K5
UV test (a)	+	n.a.	-	-	+
storage test (a)	+	n.a.	+	-	+

Key: "ja" = yes; "nein" = no
(a) + indicates: test passed
(1) carboxy methyl cellulose
(2) guar
(3) modified starch
(4) cellulose fibers
(5) aluminum stearate
(6) calcium stearate
(7) magnesium stearate
(8) zinc stearate
(9) coconut oil
(10) carrageen
(11) soy oil, hardened
n.a. not carried out

	Nr. 41	Nr. 42	Nr. 43	Nr. 44	Nr. 45
potato starch	47	50	40	50	90
other starches	53(10)	50(11)	60(12)	50(13)	-
water	130	130	130	130	145
thickening agent	0,5(1)	0,5(1)	0,5(1)	0,5(1)	10(14)
material rich in cellulose	5(4)	5(4)	5(4)	5(4)	10(4)
separating agent	2(5)	2(5)	2(5)	2(5)	2(6)
other components	-	-	-	-	-
luffing, condition	G	G	G	G	G
shaping (a)	+	+	+	+	+
adhering	nein	nein	nein	nein	nein
conditioning	K3	K3	K3	K3	K1
UV test (a)	+	+	+	+	+
storage test (a)	+	+	+	+	+

Key: "ja" = yes; "nein" = no
(a) + indicates: test passed
(1) carboxy methyl cellulose
(2) guar
(3) modified starch
(4) cellulose fibers
(5) aluminum stearate
(6) calcium stearate
(7) magnesium stearate
(8) zinc stearate
(9) coconut oil
(10) pea starch
(11) rice starch
(12) cornstarch
(13) tapioca
(14) potato starch, agglutinated

	Nr. 46	Nr. 47	Nr. 48	Nr. 49	Nr. 50
potato starch	80	90	90	95	100
water	170	110	110	165	90
thickening agent	20(10)	11,5(10) 3,0(11)	10(10) 1(12)	5(10) 5(12)	4,5(11) 0,5(1)
material rich in cellulose	-	-	-	10	-
separating agent	2(5)	2(5)	2(5)	1(7)	2(5)
other components	-	-	-	-	-
luffing, condition	λ	λ	λ	λ	λ
shaping (a)	÷	÷	+	÷	÷
adhering	nein	nein	nein	nein	nein
conditioning	K1	K1	K1	K1	K1
UV test (a)	+	÷	+	+	÷
storage test (a)	÷	+	÷	÷	÷

Key: "ja" = yes; "nein" = no
(a) + indicates: test passed
(1) carboxy methyl cellulose
(2) guar
(3) modified starch
(4) cellulose fibers
(5) aluminum stearate
(6) calcium stearate
(7) magnesium stearate
(8) zinc stearate
(9) coconut oil
(10) cornstarch, agglutinated
(11) gum arabic
(12) gelatin

	Nr. 51	Nr. 52	Nr. 53	Nr. 54	Nr. 55
potato starch	90	100	65	65	65
cornstarch	-	-	35	35	35
water	110	135	135	135	135
thickening agent	10(3)	2,5(3) 0,3(2)	0,5(1)	0,5(1)	0,5(1)
material rich in cellulose	-	5(4)	5(4)	5(4)	5(4)
separating agent	2(8)	2(8)	2(7)	2(7)	2(7)
other components	-	-	0,2(10)	0,02(11)	2(12)
luffing, condition	λ	λ	λ	λ	λ
shaping (a)	+	+	+	+	+
adhering	nein	nein	nein	nein	nein
conditioning	Kl	Kl	Kl	Kl	Kl
UV test (a)	+	+	+	+	+
storage test (a)	+	+	+	+	+

Key: "ja" = yes; "nein" = no
(a) + indicates: test passed
(1) carboxy methyl cellulose
(2) guar
(3) modified starch
(4) cellulose fibers
(5) aluminum stearate
(6) calcium stearate
(7) magnesium stearate
(8) zinc stearate
(9) coconut oil
(10) tartrazin
(11) chlorophyll, water soluble
(12) caramel

	Nr. 56	Nr. 57	Nr. 58	Nr. 59	Nr. 60
potato starch	100	100	100	100	100
water	135	140	140	160	90
thickening agent	0,5(1)	5(3)	5(3)	5(3)	-
material rich in cellulose	10(4)	10(4)	10(4)	10(4)	10(4)
separating agent	2(5)	2(6)	2(8)	2(7)	2(5)
other components	2(11)	2,5(12)	5(13)	25(14)	-
luffing, condition	E	E	E	E	E
shaping (a)	+	+	+	+	+
adhering	nein	nein	nein	nein	nein
conditioning	K1	K1	K1	K3	K3
UV test (a)	+	-	+	+	+
storage test (a)	+	-	+	+	+

Key: "ja" = yes; "nein" = no
(a) + indicates: test passed
(1) carboxy methyl cellulose
(2) guar
(3) modified starch
(4) cellulose fibers
(5) aluminum stearate
(6) calcium stearate
(7) magnesium stearate
(8) zinc stearate
(9) coconut oil
(10) caramel
(11) cocoa powder 10/12
(12) colored pigment
(13) white pigment
(14) silica gel

	Nr. 61	Nr. 62	Nr. 63	Nr. 64	Nr. 65
potato starch	100	100	50	-	100
water	70	135	115	100	130
thickening agent	-	0,5(2)	-	-	4(12)
material rich in cellulose	-	10(4)	-	-	10(4)
separating agent	2(6)	2(10)	2(8)	2(7)	2(5)
other components	-	-	50(11)	100(11)	-
luffing, condition	E	E	E	E	E
shaping (a)	+	+	+	+	+
adhering	nein	nein	nein	nein	nein
conditioning	K1	K1	K1	K1	K1
UV test (a)	+	+	+	-	+
storage test (a)	+	+	+	+	+

Key: "ja" = yes; "nein" = no
(a) + indicates: test passed
(1) carboxy methyl cellulose
(2) guar
(3) modified starch
(4) cellulose fibers
(5) aluminum stearate
(6) calcium stearate
(7) magnesium stearate
(8) zinc stearate
(9) coconut oil
(10) stearic acid amide
(11) rye flour
(12) baking residue*

* dried, ground baking residue from preliminary experiment (Nr. 62)

	Nr. 66	Nr. 67	Nr. 68	Nr. 69	Nr. 70
potato starch	100	100	100	100	100
water	130	130	130	130	130
thickening agent	0,5(2)	0,5(2)	0,5(2)	0,5(2)	0,5(2)
material rich in cellulose	10(4)	10(4)	10(4)	10(4)	10(4)
separating agent	2(10)	2(11)	2(12)	2(13)	4(13)
other components	-	-	-	-	-
luffing, condition	I	I	I	I	I
shaping (a)	+	+	+	+	+
adhering	nein	nein	nein	nein	nein
conditioning	K1	K1	K1	K1	K1
UV test (a)	+	+	+	+	+
storage test (a)	+	+	+	+	+

Key: "ja" = yes; "nein" = no
(a) + indicates: test passed
(1) carboxy methyl cellulose
(2) guar
(3) modified starch
(4) cellulose fibers
(5) aluminum stearate
(6) calcium stearate
(7) magnesium stearate
(8) zinc stearate
(9) coconut oil
(10) medium chain fatty acids*
(11) medium chain fatty acids, Al-salt
(12) medium chain fatty acids, Mg-salt
(13) medium chain fatty acids, Ca-salt

* > 70% C10, C12, C14; minor amounts smaller than C10, greater than C14.

	Nr. 71	Nr. 72	Nr. 73	Nr. 74	Nr. 75
potato starch	100	100	25	100	100
water	130	130	115	130	130
thickening agent	5(3)	4(10)	0,5(2)	0,5(2)	0,5(2)
material rich in cellulose	10(4)	10(4)	5(4)	10(4)	10(4)
separating agent	1(7)	2(5)	2(7)	2(6)	2(8)
other components	-	-	75(11)	-	-
luffing, condition	nein	nein	nein	nein	nein
shaping (a)	-	+	+	+	+
adhering	nein	nein	nein	nein	nein
conditioning	K1	K1	K1	K1	K1
UV test (a)	+	+	+	+	+
storage test (a)	+	+	+	+	+

Key: "ja" = yes; "nein" = no
(a) + indicates: test passed
(1) carboxy methyl cellulose
(2) guar
(3) modified starch
(4) cellulose fibers
(5) aluminum stearate
(6) calcium stearate
(7) magnesium stearate
(8) zinc stearate
(9) coconut oil
(10) baking residue*
(11) rice starch

* dried, ground baking residue from preliminary experiment (Nr. 65)

	Nr. 76	Nr. 77	Nr. 78	Nr. 79	Nr. 80
potato starch	100	100	100	100	100
water	100	100	130	100	100
thickening agent	0,5(2)	-	0,5(2)	0,5(2)	0,5(2)
material rich in cellulose	10(4)	10(4)	10(4)	-	10(4)
separating agent	2(7)	2(7)	2(7)	2(7)	2(7)
other components	0,1(10)	0,5(10)	0,2(10)	0,1(10)	0,05(10)
luffing, condition	I	I	I	I	I
shaping (a)	+	+	+	+	+
adhering	nein	nein	nein	nein	nein
conditioning	K5	K5	K5	K5	K5
UV test (a)	+	+	+	+	+
storage test (a)	+	+	+	+	+

Key: "ja" = yes; "nein" = no
(a) + indicates: test passed
(1) carboxy methyl cellulose
(2) guar
(3) modified starch
(4) cellulose fibers
(5) aluminum stearate
(6) calcium stearate
(7) magnesium stearate
(8) zinc stearate
(9) coconut oil
(10) zirconium carbonate solution (Bacote 20, Magnesium Elektron)
(11) calcium carbonate, pulverized

	Nr. 81	Nr. 82	Nr. 83	Nr. 84	Nr. 85
potato starch	100	100	100	100	100
water	90	90	100	50	80
thickening agent	-	-	-	-	-
material rich in cellulose	5(4)	-	5(4)	-	5(4)
separating agent	2(6)	2(6)	2(6)	2(7)	2(7)
other components	5(10)	10(10)	20(10)	-	-
luffing, condition	I	I	I	I	I
shaping (a)	+	+	+	+	+
adhering	nein	nein	nein	nein	nein
conditioning	K5	K5	K5	K3	K3
UV test (a)	+	+	+	+	+
storage test (a)	+	+	+	+	+

Key: "ja" = yes; "nein" = no
(a) + indicates: test passed
(1) carboxy methyl cellulose
(2) guar
(3) modified starch
(4) cellulose fibers
(5) aluminum stearate
(6) calcium stearate
(7) magnesium stearate
(8) zinc stearate
(9) coconut oil
(10) calcium carbonate, pulverized

	Nr. 86	Nr. 87	Nr. 88	Nr. 89
wheat flour	100	100	-	-
potato starch	-	-	100	100
water	100	100	130	100
thickening agent	-	1(2)	0,3(2)	-
material rich in cellulose	-	10(4)	10(4)	10(4)
separating agent	2(8)	2(7)	2(7)	2(7)
other components	-	-	25(10)	2,5(10)
luffing, condition	I	I	I	I
shaping (a)	+	+	+	+
adhering	nein	nein	nein	nein
conditioning	K3	K3	K3	K3
UV test (a)	—	—	+	+
storage test (a)	+	+	+	+

Key: "ja" = yes; "nein" = no

(a) + indicates: test passed

(1) carboxy methyl cellulose

(2) guar

(3) modified starch

(4) cellulose fibers

(5) aluminum stearate

(6) calcium stearate

(7) magnesium stearate

(8) zinc stearate

(9) coconut oil

(10) talcum

(11) calcium carbonate, pulverized

	Nr. 90	Nr. 91	Nr. 92
cornstarch	100	100	100
water	130	130	130
thickening agent	0,7(2)	0,7(2)	0,7(2)
material rich in cellulose	10(4)	10(4)	10(4)
separating agent	2(5)	2(5)	2(5)
other components	-	10(11)	20(10)
luffing, condition	A	A	A
shaping (a)	+	+	+
adhering	nein	nein	nein
conditioning	K3	K3	K3
UV test (a)	+	+	+
storage test (a)	+	+	+

Key: "ja" = yes; "nein" = no
(a) + indicates: test passed
(1) carboxy methyl cellulose
(2) guar
(3) modified starch
(4) cellulose fibers
(5) aluminum stearate
(6) calcium stearate
(7) magnesium stearate
(8) zinc stearate
(9) coconut oil
(10) talcum
(11) calcium carbonate, pulverized

	Nr. 93	Nr. 94	Nr. 95	Nr. 96
potato starch	100	100	100	100
water	140	140	100	150
thickening agent	0,5(2)	0,5(2)	0,5(2)	0,5(2)
material rich in cellulose	10(4)	10(4)	-	10(4)
filler	2,5(11)	2,5(11)	-	-
separating agent	2(7)	2(7)	2(7)	2(7)
other components	0,2(10)	0,4(10)	0,2(10)	0,3(10)
" "	0,01(12)			
luffing, condition	A	A	A	A
shaping (a)	+	+	+	+
adhering	nein	nein	nein	nein
conditioning	K3	K3	K3	K3
UV test (a)	+	+	+	+
storage test (a)	+	+	+	+

Key: "ja" = yes; "nein" = no
(a) + indicates: test passed
(1) carboxy methyl cellulose
(2) guar
(3) modified starch
(4) cellulose fibers
(5) aluminum stearate
(6) calcium stearate
(7) magnesium stearate
(8) zinc stearate
(9) coconut oil
(10) Bacote 20
(11) calcium carbonate, pulverized
(12) chlorophyll (dye)

	Nr. 97	Nr. 98	Nr. 99	Nr. 100	Nr. 101
potato starch	100	100	100	100	100
water	120	120	120	120	120
thickening agent	0,5(2)	0,5(2)	0,5(2)	0,5(2)	0,5(2)
material rich in cellulose	10(4)	10(4)	10(4)	10(4)	10(4)
separating agent	2(7)	2(7)	2(7)	2(7)	2(7)
other components	2(10)	2(11)	2(12)	2(13)	2(14)
luffing, condition	I	I	I	I	I
shaping (a)	+	+	+	+	+
adhering	nein	nein	nein	nein	nein
conditioning	K3	K3	K3	K3	K3
UV test (a)	+	+	+	+	+
storage test (a)	+	+	+	+	+

Key: "ja" = yes; "nein" = no
(a) + indicates: test passed
(1) carboxy methyl cellulose
(2) guar
(3) modified starch
(4) cellulose fibers
(5) aluminum stearate
(6) calcium stearate
(7) magnesium stearate
(8) zinc stearate
(9) coconut oil
(10) sodium caseinate
(11) soy isolate
(12) wheat gluten
(13) egg albumen powder
(14) casein

	Nr. 102	Nr. 103	Nr. 104	Nr. 105	Nr. 106
wheat flour	-	-	-	100	-
potato starch	100	100	100	-	100
water	130	140	150	130	150
thickening agent	0,5(2)	0,5(1)	0,5(1)	1(2)	0,5(2)
material rich in cellulose	5(4)	10(4)	5(4)	10(4)	-
separating agent	1(7)	2(7)	2(7)	2(7)	2(7)
other components	6(9)	25(10)	10(10)	10(10)	30(11)
luffing, condition	A	A	A	A	A
shaping (a)	+	+	+	+	+
adhering	nein	nein	nein	nein	nein
conditioning	K3	K3	K3	K3	K3
UV test (a)	+	+	+	+	+
storage test (a)	+	+	+	+	+

Key: "ja" = yes; "nein" = no
(a) + indicates: test passed
(1) carboxy methyl cellulose
(2) guar
(3) modified starch
(4) cellulose fibers
(5) aluminum stearate
(6) calcium stearate
(7) magnesium stearate
(8) zinc stearate
(9) shellac, powdered
(10) activated carbon, pulverized
(11) cellulose, acetylated

	Nr. 107	Nr. 108
potato starch	100	100
water	130	130
thickening agent	0,5(2)	0,3(2)
material rich in cellulose	10(4)	10(4)
separating agent	2(7)	2(5)
other components	10(11)	25(10)
luffing, condition	A	I
shaping (a)	+	+
adhering	nein	nein
conditioning	K3	K3
UV test (a)	+	+
storage test (a)	+	+

Key: "ja" = yes; "nein" = no
(a) + indicates: test passed
(1) carboxy methyl cellulose
(2) guar
(3) modified starch
(4) cellulose fibers
(5) aluminum stearate
(6) calcium stearate
(7) magnesium stearate
(8) zinc stearate
(9) coconut oil
(10) aluminum oxide
(11) cellulose, acetylated

	Nr. 109		Nr. 110		Nr. 111		Nr. 112		Nr. 113	
to starch	100		100		100		100		100	
:r	120		120		120		120		120	
:ening agent	0,5	(2)	0,5	(2)	0,5	(2)	0,5	(2)	0,5	(2)
:rial rich in cellulose	10	(4)	10	(4)	10	(4)	10	(4)	10	(4)
rating agent	2	(7)	1	(7)	-		-		-	
r components	-		0,5	(9)	1	(9)	5	(9)	10	(9)
ng, condition	I		I		I		I		I	
ing (a)	+		+		+		+		+	
:ring	nein		nein		nein		nein		nein	
litioning	K3		K3		K3		K3		K3	
test (a)	+		+		+		+		+	
ige test (a)	+		+		+		+		+	

: "ja" = yes; "nein" = no
+ indicates: test passed
ɔxy methyl cellulose
ᵹuar
modified starch
cellulose fibers
aluminum stearate
calcium stearate
magnesium stearate
zinc stearate
polymethyl hydrogen siloxane, Dow Corning 1107 fluid

	Nr. 116	Nr. 117	Nr. 118	Nr. 119	Nr. 120
starch	100 (1)	100 (1)	100 (1)	100 (2)	100 (2)
water	120	115	150	100	130
thickening agent	0,8 (4)	0,7 (4)	0,7 (4)	0,5 (4)	0,5 (4)
material rich in cellulose	5 (5)	-	-	10 (5)	10 (5)
separating agent	2 (11)	2 (11)	2 (11)	2 (10)	2 (10)
other components	-	10 (6)	25 (6)	-	-
luffing, condition	-	I	I	-	I
shaping (a)	+	+	+	+	+
adhering	nein	nein	nein	nein	nein
conditioning	(b)	(b)	(b)	(b)	(b)
UV test (a)	+	+	+	+	+
storage test (a)	+	+	+	+	+

Key: "ja" = yes; "nein" = no
(a) + indicates: test passed
(b) 15°C, 78% RH, 180 minutes
(1) potato starch
(2) tapioca
(3) amylo cornstarch
(4) guar
(5) cellulose fibers
(6) polyhydroxy butyric acid, test sample in flocculated form
(7) potato pulp, fresh
(8) dried beet pulp, dried, ground
(9) flat fibers, fiber length less than 5 mm
(10) calcium stearate
(11) magnesium stearate

	Nr. 121	Nr. 122	Nr. 123	Nr. 124	Nr. 125
starch	100 (1)	100 (1)	100 (1)	100 (1)	100 (1)
water	67,5	75	87,5	127	130
thickening agent	0,5 (4)	0,5 (4)	0,5 (4)	0,5 (4)	0,5 (4)
material rich in cellulose	-	-	-	-	-
separating agent	2 (11)	2 (11)	2 (11)	2 (11)	2 (11)
other components	62,5 (7)	33 (7)	62,5 (7)	33 (7)	10 (9)
luffing, condition	I	I	I	I	-
shaping (a)	+	+	+	+	+
adhering	nein	nein	nein	nein	nein
conditioning	(b)	(b)	(b)	(b)	(b)
UV test (a)	+	+	+	+	+
storage test (a)	+	+	+	+	+

Key: "ja" = yes; "nein" = no
(a) + indicates: test passed
(b) 15°C, 78% RH, 180 minutes
(1) potato starch
(2) tapioca
(3) amylo cornstarch
(4) guar
(5) cellulose fibers
(6) polyhydroxy butyric acid, test sample in flocculated form
(7) potato pulp, fresh
(8) dried beet pulp, dried, ground
(9) flat fibers, fiber length less than 5 mm
(10) calcium stearate
(11) magnesium stearate

	Nr. 125	Nr. 127	Nr. 128
starch	100 (1)	100 (1)	90 (2)
water	130	130	100
thickening agent	0,5 (4)	0,5 (4)	0,3 (4)
material rich in cellulose	-	-	-
separating agent	2 (10)	2 (10)	2 (11)
other components	10 (8)	20 (8)	10 (3)
luffing, condition	I	I	I
shaping (a)	+	+	+
adhering	nein	nein	nein
conditioning	(b)	(b)	(b)
UV test (a)	+	+	+
storage test (a)	+	+	+

Key: "ja" = yes; "nein" = no

(a) + indicates: test passed
(b) 15°C, 78% RH, 180 minutes
(1) potato starch
(2) wheat starch
(3) amylo cornstarch
(4) guar
(5) cellulose fibers
(6) polyhydroxy butyric acid
(7) potato pulp, fresh
(8) dried beet pulp, dried, ground
(9) flat fibers, fiber length less than 5 mm
(10) calcium stearate
(11) magnesium stearate

Part 2 (pp. 88 - 102 of German document)

The above tests allow the following conclusions:

Recipes with fat or lecithin as parting agents
(Nos. 2, 4, 6, 24, 25, 26, 39)

In the individual test sequences, recipes with the addition of fats, particularly hydrogenated coconut and soybean fats, were utilized for comparison. Although the above fats contain primarily saturated fatty acids, notable problems - rancid or musty off-odors - were encountered in UV tests and in storage tests. This is also true when lecithin is used as a parting agent (test 24). In higher concentrations of substances rich in cellulose, problems arise, despite the addition of fat, due to sticking of the baked product (test no. 4, 37).

Comparison recipe without parting agent
(No. 1)

Even when the mold is clean and ready for baking, this recipe results in more and more sticking of the final baked product and to visible residues in the baking molds after only a few baking cycles.

Cellulose fibers as cellulose-rich material
(Tests 3-5 compared to 7 ff; 60 compared to 61)

Cellulose fibers -- like other fibrous materials -- increase the mechanical stability of the final, conditioned product. However, this stability is partially reduced by increased porosity -- as the result of increased water absorption by the mixture and a greater release of water vapor during the baking process -- but permits the manufacture of products with modified properties: lower density, higher flexibility. Despite the high water content in cellulose-rich mixtures (tests 4, 5), no steam-release problems occur which could be traced back to the absence of an emulsifying agent.

Fiber length, dimensions of fibrous materials

The length of cellulose fibers used ranged between 30 micrometers (very short fibers) and 1500 micrometers (long fiber quality). Problems caused by excessively large fiber dimensions were less apparent in terms of filling the mold with the correct amount of baking mixture -- filling systems different from those employed for waffles could be used for viscous mixtures (more than 2000 mPas), paste-like mixtures (tests 60, 61, 63, 64) or mixtures containing fibrous materials -- than in terms of blocking the steam release openings in the baking molds. For this reason, other fibrous materials, particularly groundwood and straw fibers, were crushed and sifted (1 mm mesh width or smaller) before being used.

Use of fat plus a parting agent
(Test 6)

Fats and parting agents can be used together; however, the oxidative stability is reduced.

Parting agent concentrations
(Tests 11 - 13)

Even greatly increasing the amount of the parting agent does not cause any baking problems and results in a precisely formed molding -- a result inconceivable with the use of traditional fats as the parting agent.

Traditional parting agents
(Tests 10, 11, 19)

Waxes, such as beeswax or paraffin waxes, that were or are used to coat the baking mold to prevent initial sticking each time a new production run is stared with automatic waffle baking machines, for example, are not suitable. Neither is magnesium oxide which is used occasionally together with fat and lecithin as a parting agent in waffle recipes.

Moisturizers
(Tests 16-18)

The addition of moisturizing agents has a positive affect on moisture absorption and can offer advantages in terms of stability from a microbiological point of view; during baking, however, the structure of the molding becomes looser.

Other parting agents: Carboxylic acid and its salts; amic acids
(Tests 20 - 23, 41, 45, 53, 62)

Both the free acids and various salts are suitable from a technical point of view.

Of the metallic soaps used in the individual tests, those with multivalent cations are preferable (Al, Ca, Mg, Zn), since they result in the most neutral products from a sensory standpoint in contrast to sodium salt. This is especially important when the products are filled with sensitive goods (e.g., foods).

Various cellulose-rich materials
(Tests 27 - 30)

Examples of different fibrous materials that provide additional strength. Wheat bran requires prior degreasing to ensure stability against oxidative deterioration. The raw materials mentioned increase the amount of water required for preparing the baking mixture and in some cases the mixtures used to fill the molds have

a pasty consistency with viscosities clearly exceeding 2000 mPas.

Wheat flour as a raw material rich in starch
(Tests 31 - 40)

Wheat flour is available almost everywhere and is a an easily producible raw material rich in starch. Its predominant or exclusive use causes two kinds of problems which can, however, be solved.

1. Wheat flour contains approx. 1 - 1.5% by weight lipids containing mainly unsaturated fatty acids. The addition of increasing amounts of wheat flour results in a slightly rancid odor, detectable by an expert at least, in a UV test. In the storage test, the odor is less noticeable, apparently due to the constant evaporation of the minute traces of these very odor-intensive substances.

   The addition of antioxidants which are not released with the steam but are distributed during the baking process once the mixture flows reduces these changes. Comparable effects can be achieved with other antioxidants such as those utilized in plastics manufacture.

2. The gluten content of the wheat flour, apparently because the gluten binds with the parting agent, weakens the parting effect. This problem can be solved actively by increasing the amount of parting agent in the recipe and passively by adding materials rich in cellulose (diluting effect).

Use of preservatives
(Test 33)

Here, the use of a preservative is shown as an example. Analogous to paper manufacture, such additives are provided when exposure to moisture of the molding cannot be precluded during the course of its use.

Other raw materials rich in starch
(Tests 41 - 44, 63 ff)

The use of other raw materials rich in starch, such as starches from various plants, as well as cereal flours, is also possible. The individual raw materials influence the color and strength of the structure of the molding in specific ways. Natural pigments from raw materials, such as corn flour and corn starch pigments, rapidly fade during the storage and UV tests.

The statements about the limited oxidative stability of wheat flour also apply similarly to other cereal flours (rye flour, barley flour, millet flour, corn flour).

Thickeners

Besides the non-starch-based thickening agents mentioned in examples 11, 15, 26, 35, 45 - 49, 51, 52, 57 - 59, modified starches that provide a thickening action by first converting them to a pasty mass or through chemical modification can also be used.

Pigments

For the production of pure white molds, potato starch works best. The addition of water soluble pigments is shown in tests 55 - 56 as examples.

Fillers

Fillers, as materials not significantly involved in creating the structure of the molding but rather as passively included materials, alter the density (example 59), the compressive strength, or the appearance of the product (pigments 57, 58), for example.

Silica gel used in example 59 as a sample of a hard glass-like material is almost spherical in shape. Fibrous materials of this kind are no longer considered the only possible fillers.

Water content of the baking mixture

The water content of the baking mixture, as shown in the examples, can vary widely. This is due to 2 factors:

1. Water absorption in raw materials: cellulose-rich raw materials or flours in particular require larger higher amounts of water than starches in order to attain a certain baking mixture viscosity.

2. Desired consistency: In general, baking mixtures with a viscosity of between 500 and 3000 mPas, preferably 1000 - 2000 mPas, are used or else dough-like, no longer free-flowing, kneadable or even no longer cohesive mixtures (see recipes 61, 62)

To determine the limits of the process proposed by the invention, moldings were produced which were increasingly rich in starch.

Example I

Raw materials rich in starch:

	potato starch(*)	100 parts by weight
	water	x parts by weight
	parting agent, thickener	1.5 parts by weight

* water content 17.5% by weight

	Parts by weight, added water x	Consistency of mixture	% by weight of water content in recipe
I a	83.2	free-flowing	55.0
I b	73.9	pasty	42.1
I c	64.9	plastic	39.0
I d	55.8	non-cohesive	35.5
I e	46.7	non-cohesive	31.5
I f	37.4	non-cohesive	26.9
I g	28.2	non-cohesive	21.7

Microscopic, sensory, and physical tests show that moldings I f and I g already exhibit undesirable characteristics: abrading of unbonded particles, discontinuity in the modulus of elasticity and in the breaking strength.

Example II

Raw material rich in starch:

wheat flour, type 550(*)	100 parts by weight
water	x parts by weight
parting agent	1 part by weight

* water content 13.2% by weight

	Parts by weight, added water x	Consistency of mixture	% by weight of water content in recipe
II a	92.9	plastic, soft	47.9
II b	83.1	plastic	45.1
II c	73.6	plastic	42.2
II d	64.1	plastic	38.8
II e	54.4	plastic, dry	35.0
II f	44.7	firm, crumbly	30.7
II g	35.0	less cohesive	25.7

The II g test moldings showed clearly undesirable characteristics in terms of breaking behavior.

The thin-walled moldings resulting from the process under the invention exhibit the following characteristics:

- A largely non-porous surface
  Electron-microscope examination showed an external skin with the typical structure of a starch paste with isolated inclusions of fillers and binding agents.
- A foam-like core structure
  Under the external skin is a porous middle layer with the pore

size increasing toward the center. This is important for properties such as impact absorption and thermal insulation. In comparison to the well-known edible waffles and wafers, there is no occasional splitting down the center of this middle layer - also known as delamination, peeling or splitting.

- Elastic and plastic behavior
  Because of the conditioning that follows baking, the material is increasingly able to be shaped by pressure. Due to the incorporation of water, the glass point is exceeded. This occurs at room temperature usually beginning with a water content above 6% by weight and continues over a wide range of water content up to 22% by weight. Only above these values is there a softening and flowing together of the material similar to the melting of solids.

  This water content represents the equilibrium moisture content and adjusts depending on temperature and relative humidity (rh). Because of the composition, there is a wide range of increased mechanical stability both at high relative humidity (up to approx. 85% rh) and at low relative humidity (down to approx. 35% rh, hysteresis) when natural starch that has been converted to a pasty mass is the principal raw material.
- Stability with respect to the effects of light and atmospheric oxygen
  When exposed to light and oxygen, the product exhibits no changes in its mechanical properties (embrittlement) and no formation of substances detectable by the senses of taste and smell.

  In contrast to waffles and wafers, all products manufactured according to the invention are based on polysaccharides and are stable in this respect.

  Possible changes in color are only noticeable when light-sensitive pigments are used.

Patent Claims

1. Process for the manufacture of biodegradable, thin-walled moldings, such as tubs, plates, fast food packaging, trays, flat sheets and the like by placing a baking mixture based on starch into the bottom half of a multiple-part -- preferably two-part -- mold, baking the molding by heating the closed mold and subsequently conditioning the baked product, whereby the following steps are taken in order to obtain a resilient, firm product with high mechanical stability

1) an essentially fat-free baking mixture composed of the following ingredients is used:

a) 30 to 63% by weight water, preferably 42.0 to 58.0% by weight;

b) as the starch base, 27.0 to 69% by weight, preferably 36 to 56.5% by weight, specifically 44 to 49% by weight starch or a mixture of different starches and/or flour or a flour mixture;

c) as the parting agent, 0.04 to 11% by weight, preferably 0.2 to 4.5% by weight of one or more medium- or long-chain (possibly substituted) fatty acids and/or their salts and/or their acid derivatives, e.g., amic acids -- sometimes 0.5 to 6.5% by weight, preferably 0.1 to 4.2% by weight, polymethyl hydrogen siloxane can be used in addition to these compounds or as a partial or in some cases complete substitute for them. If both compound groups are used with high concentrations of fatty acids or their compounds, the polymethyl hydrogen siloxane concentration should generally not exceed 3% by weight;

d) 0 to 10% by weight, preferably 0.1 to 7.5% by weight, thickener -- specifically 1.0 to 5.5% by weight swelling starch, starch that has been converted to a pasty mass, or baking waste and/or 0 to 2% by weight, preferably 0 to 1.0% by weight guar flour, pectin, locust bean flour, carboxymethylcellulose and/or 0 to 5.5% by weight, preferably 0 to 3% by weight, gum acacia;

e) 0 to 16.0% by weight, preferably 0 to 11% by weight, cellulose-rich raw materials -- in the case of pulps, up to 26.9% by weight -- and/or other plant fibers and/or plastic, glass, metal, carbon fibers and others;

f) 0 to 10% by weight, preferably 0 to 7.5% by weight

of non-fiber fillers such as
calcium carbonate,
coal,
talcum,
titanium dioxide,
silica gel,
aluminum oxide;
0 to 3% by weight, preferably 0 to 2.5% by weight, shellac;
0 to 2.0% by weight, preferably 0 to 1.0% by weight, powdered soy protein, powdered wheat gluten, powdered chicken protein, powdered casein and powdered caseinate;

g) as a moisturizer
0 - 3.5% by weight, preferably 0 - 2.5% by weight common salt and/or
0 - 2.5% by weight, preferably 0 - 1.5% by weight glycerin, glycols and/or
0 - 4.5% by weight, preferably 0 - 3.5% by weight sorbitol;

h) as a coloring agent
0 - 10% by weight, preferably 0 - 7.5% by weight inorganic pigments and/or
0 - 0.1% by weight natural or synthetic pigments and/or
0 - 2.5% by weight, preferably 0 - 1% by weight, caramel, and/or
0 - 1% by weight soot, and/or
0 - 3.5% by weight, preferably 0 - 2.5% by weight cacao powder

i) as a structural stiffener, a zirconium salt solution, preferably in the form of an alkaline solution of ammonium zirconium carbonate, where the zirconium-compound content, expressed as ZrO_2, is 0 to 0.1% by weight, preferably 0.01 to 0.05% by weight;

k) 0 - 0.25% by weight, preferably 0 - 0.1% by weight, preservatives and

l) 0 - 0.5% by weight, preferably 0 - 0.1% by weight, antioxidants.

2) the baking mixture in the baking mold is baked for 25 to 230 seconds at 145 - 230°C, and

3) the resulting product is conditioned to adjust the moisture content to 6 - 22% by weight.

2. Process as claimed in Claim 1, wherein the baking mixture contains potato starch and/or corn starch and/or wheat starch and/or rice starch and/or tapioca starch as the starch base.

3. Process as claimed in Claims 1 or 2, wherein the starch base of the baking mixture contains 5 to 100% by weight, preferably 5 to 95% by weight, potato starch in relation to the total starch content.

4. Process as claimed in one or more of Claims 1 through 3, wherein the baking mixture contains one or more fatty acids with a chain length longer than C_{12}, preferably C_{16} to C_{18}, and/or their salts and/or acid derivatives as the parting agent.

5. Process as claimed in Claim 4, wherein the baking mixture contains stearic acid and/or its sodium, calcium, magnesium, aluminum and zinc salts, especially the aluminum, magnesium and zinc salts, as a parting agent.

6. Process as claimed in one or more of Claims 1 through 5, wherein the baking mixture contains a polymethyl hydrogen siloxane having the general formula

$$R_3S10(SiH(Ch_3)O)_n\ SiR_3$$

where R stands for H, methyl or alkyl, and, in the event that R is methyl, n is a number between approx. 40 and approx. 100.

7. Process as claimed in one or more of Claims 1 through 6, wherein the baking mixture contains, as a thickener, starches that have been converted to a pasty mass either as a finished product such as swelling starch or swelling flour, or as a product manufactured immediately prior to preparing the dough.

8. Process as claimed in Claim 7, wherein the starch that has been converted to a pasty mass makes up 1 to 10% by weight, preferably 2 to 5% by weight, of the total starch content.

9. Process as claimed in one or more of Claims 1 through 8, wherein the baking mixture contains, as cellulose-rich raw materials, 0 - 16% by weight substances with limited water-absorbency (e.g., wood chips) and/or 0 - 28% by weight highly water-absorbent substances (e.g., pulps) and/or 0 -11% by weight, preferably 0 - 5% by weight, other fibrous substances.

10. Process as claimed in one or more of Claims 1 through 9, wherein the baking mixture contains 0 - 10% by weight, preferably 0 - 7.5% by weight, non-fibrous, largely inert fillers (inorganic substances, charcoal, etc.) and/or 0 - 2% by weight, preferably 0 - 1% by weight, proteins and/or 0 - 3% by weight, preferably 0 - 2.5% by weight, shellac.

11. Process as claimed in one or more of Claims 1 through 10, wherein the baking mixture contains fillers and binding agents in the following concentrations in relation to the dry components of the baking mixture:

Calcium carbonate 0.1 - 17.2% by weight, preferably 0.4 - 13.2% by weight, and/or
Talcum 0.1 - 12.5% by weight, preferably 0.4 - 9.5% by weight, and/or
acetylized cellulose 0.1 - 14.1% by weight, preferably 0.4 - 11.7% by weight, and/or
Aluminum oxide 0.1 - 12.5% by weight, preferably 0.4 - 9.5% by weight, and/or
activated charcoal 0.1 - 12% by weight, preferably 0.4 - 8.4% by weight, and/or
Shellac 0.1 - 5% by weight, preferably 0.4 - 3.5% by weight.

12. Process as claimed in Claim 10, wherein a pre-beaten baking mixture is used which contains the following proteins for stabilizing the pore structure and/or for achieving a "beaten effect"(?) (in % by weight of the dry components in the baking mixture):

Casein 0.1 - 2.6% by weight, preferably 0.2 - 1.3% by weight, and/or natrium caseinate 0.1 - 1.3% by weight, preferably 0.2 - 1.0% by weight, and/or
Soy solate 0.1 - 2.6% by weight, preferably 0.2 - 1.7 % by weight, and/or
Chicken protein 0.1 - 1.7% by weight, preferably 0.2 - 1.0% by weight.

13. Process as claimed in one or more of Claims 1 through 12, wherein a material-composite consisting of base molding and the materials fused to it during baking is produced by adding flat and/or threadlike materials to the baking mold.

14. Process as claimed in Claim 13, wherein the addition of these flat or threadlike materials takes place before and/or after filling the bottom half of the baking mold with the baking mixture.

15. Process as claimed in Claim 13 or 14, wherein a baked product resulting from the process as claimed in one or more of Claims 1 through 12 is used as the flat material.

16. Application of the process as claimed in Claim 13 to a process in which baking mixtures well known in waffle and wafer production are used without the components fat and lecithin as parting agents.

17. Process as claimed in one or more of Claims 1 through 15, wherein the baking mold is briefly opened slightly, preferably several times, during the baking process.